PLANT CELL BIOLOGY AND DEVELOPMENT

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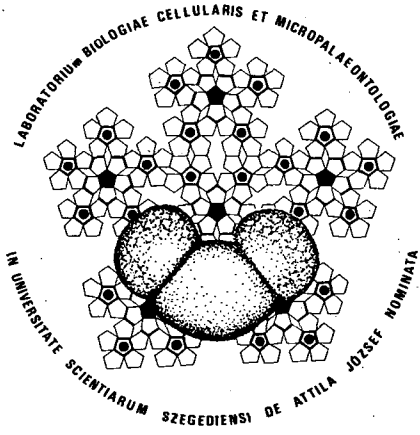

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Contributors

Concepcion ALVAREZ RAMIS
Departamento de Paleontologia, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, Madrid, Spain, catedrático.

Andrea BORBOLA
Cell Biological and Evolutionary Micropaleontological Laboratory. University Student.

Anna BORSODI
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Jean DEJAX
Muséum National d'Histoire Naturelle, Laboratoire de Paléontologie, URA 12 CNRS, Paris, France, Maître des Conférences.

Krisztina DOBÓ
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Sándor GULYÁS
Department of Geology and Paleontology of the J.A. University, PhD Student.

Andrea HORVÁTH
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Erika HORVÁTH
Cell Biological and Evolutionary Micropaleontological Laboratory. University Student.

Eszter HORVÁTH
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Tímea KANCSÁR
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Ágnes KÁROSSY
Cell Biological and Evolutionary Micropaleontological Laboratory. Laboratory Assistant.

Miklós KEDVES
Cell Biological and Evolutionary Micropaleontological Laboratory. Honorary Professor.

Edit KOVÁCS
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Madhav KUMAR
Birbal Sahni Institute of Palaeobotany, Uttar Pradesh, India. Scientist C.

Pramod KUMAR
Birbal Sahni Institute of Palaeobotany, Uttar Pradesh, India. Scientist D.

Eliso V. KVAVADZE
L. Sh. Davitashvili Institute of Palaeobotany, Georgia Academy of Sciences. Tbilisi, Georgia, Professor.

Nabila LAAMARTI
Departamento de Paleontologia, Facultad de Ciencias Geologicas, Universidad Complutense de Madrid, Madrid, Spain.

Jorgeo Adalberto LAGOS
Universidad Salvadoreña "Alberto Mansferrer", San Salvador, El Salvador. Profesor.

Magdolna MADARÁSZ
Cell Biological and Evolutionary Micropaleontological Laboratory. Laboratory Assistant.

Árpád PÁRDUTZ
Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences. Research Councillor, Honorary Professor.

Marguerite SALARD-CHEBOLDAEFF
Muséum National d'Histoire Naturelle, Laboratoire de Paléontologie, URA 12 CNRS, Paris, France, Maître des Conférences.

Judit SASHALMI
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Anita SZÉCSÉNYI
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Miklós SZÓNOKY
Department of Geology and Paleontology of the J.A. University. Associate Professor.

Zsuzsanna TERBE
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Dóra TOMBÁCZ
Cell Biological and Evolutionary Micropaleontological Laboratory. Grammar-school Student.

Surya, Kant Mani TRIPATHI
Birbal Sahni Institute of Palaeobotany, Uttar Pradesh, India. Scientist D.

Jorge VEGAS
Dept. U.E.I. de Petrologia UCM/CSIC, Madrid, Spain.

Preface

The Millenium is a great festival in the World. Several organizations and manifestations are in progress everywhere. For the history of Hungary it is very important that the first King, ST. STEPHAN was crowned in 1000, so this was the birth of the State of Hungary. For the science of Hungary it is also important, that 2000 will be the 175th Anniversary of the Hungarian Academy of Sciences.

Our Laboratory in its modest possibilities is preparing the celebration of this great occasion. The 2000th number of Plant Cell Biology and Development appeared in a greater extent as usually. Several authors from different countries contributed to this volume. On the 21th August of 2000 we want to organize a greater celebration than earlier because this will be the 10th Anniversary of the Laboratory. The first number of Plant Cell Biology and Development of the coming Millenium will inform from this important occasion.

The 21th August this year the following three foreign colleagues were awarded with the Commemorative Medal of the Laboratory:

Prof. Dr. S. NILSSON (Palynologiska laboratoriet, Naturhistoriska riksmuseet, Stockholm, Sweden) for his excellent results on the Palynology of recent sporomorphs, in particular of the *angiosperm* pollen grains. His contribution to modern Aeropalynology is worldwide recognized. As the chief-editor of the review Grana he continued the famous, and high standard tradition of Prof. Dr. G. ERDTMAN for the international Palynology.

Dr. J.R. ROWLEY (Stockholms Universitet, botaniska institutionen, Stockholm, Sweden), achieved basic and very important results on the transmission electron microscopy of the sporomorphs, in particular on recent pollen grains. He published several important papers on the sub-units of the sporoderm, among others the helical structures are the most important. He is always using the new methods and techniques, his concepts of researches are multidisciplinary and modern.

Dr. S.K.M. TRIPATHI (Birbal Sahni Institute of Palaeobotany, Lucknow, India), for his very important contribution in the realization of the joint research programs of the B.S.I.P. and the C.B.E.M.L.. The subject of our first researches was the biopolymer organization and symmetry of the partially degraded wall of *Botryococcus braunii* KÜTZ, isolated from Hungarian oil shale. Experimental LM and TEM investigations on palm pollen grains from India followed this.

Dr. MADHAV KUMAR (Birbal Sahni Institute of Palaeobotany, Lucknow, India) was awarded with the Diploma of the Laboratory for his important contribution in the realization of the joint research programs of the Indian National Academy of Sciences and the Hungarian Academy of Sciences.

In this place I would like to express my sincerest appreciation for the youth working in my Laboratory, in the first place to the students of the Radnóti Miklós Secondary School, and its teachers also, Drs. Mrs. E. KISS, and Mrs. E. MUSTÁRDY. The activity, the energy and the talent of the young generation is a guarantee for the science in the

future. The authors are very thankful to Ass. Prof. Dr. R. ZÁNTHÓ (Department of the English Language of the J. Gy. High School, Szeged) for linguistic corrections to the English texts. Thanks are due for her excellent work to Miss M. MADARÁSZ assistant of the Laboratory who in her leasure time is working in the realization of several research programs. She is always helpful to everybody in the Laboratory. Many thanks to the Juhász Printing Office, personally to Mr. P. JUHÁSZ, Head and to Mr. Z. KORPA co-worker of the undertaking for the excellent cooperation.

The presentation of this volume was possible only with the generous contribution of several institutions I would like to express my sincerest thanks to the following persons and institutions:

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to Prof. Dr. GY. TELEGDY member of the Hungarian Academy of Sciences,
to Prof. Dr. R. MÉSZÁROS, Rector of the the J. A. University
to Prof. Dr. K. VARGA, Dean of the Faculty of Science of the J.A. University.

On the other hand it is regrettable that the Foundation for Szeged, and the Local Government of Szeged is lacking among the contributors.

Szeged, 30. December, 1999.

M. KEDVES
Head of the Laboratory

1. PALYNODATING OF DENWA FORMATION, SATPURA BASIN, INDIA

PRAMOD KUMAR

Birbal Sahni Institute of Palaeobotany, Lucknow-226007, India

Abstract

Palynomorphs recovered from the clays of Denwa Formation from a well cutting south of village Anhoni, Satpura Basin, Madhya Pradesh include pollen-spores, *Dinocysts*, fungal, cuticles and tracheidal remains. Quantitatively three palynoassemblages are recognized: Palynoassemblage - A contains *Falcisporites, Satsangisaccites, Minutosaccus;* Palynoassemblage - B has *Dinocysts, Falcisporites, Satsangisaccites, Brachysaccus, Samaropollenites* and palynoassemblage - C possesses *Brachysaccus, Falcisporites, Aratrisporites, Ashmoripollis, Corollina, Monolites.*

The palynoassemblage of Denwa Formation from Anhoni region is comparable with the Late Triassic palynoassemblages known from the Tiki Formation of South Rewa Gondwana Basin, Dubrajpur Formation of Rajmahal Basin. - D of Krishna-Godavari Basin and *Samaropollenites speciosus* and *Ashmoripollis reducta* Oppel Zones (Norian-Rhaetian) of Carnarvon Basin from north-western Australia.

Key words: Palynodating, Late Triassic (Norian-Rhaetian), Denwa Formation, Satpura Basin.

Introduction

Denwa Formation constitutes the middle unit of the Mahadeva Group (in the type area) in the Satpura Basin, Madhya Pradesh (MEDLICOTT, 1873). It is overlain by Bagra conglomerate or Jabalpur Formation and is underlain by the Pachmarhi Sandstone. Later, CROOKSHANK (1936) studied the geology of the northern slopes of the basin. He suggested an Upper Triassic age to this formation, on the basis of animal *labyrinthodont* remains. *Mastodonsaurus indicus* LYDEKKAR (1885) which is very closely allied to *Mastodonsaurus giganteus* JÄGER from the Keuper (Late Triassic). CHATTERJEE and ROY CHOWDHURY (1974) identified *Metaposaurus* and *Paratosaurus* and suggested late Lower Triassic to Middle Triassic age to the Denwa sediments. Some leaf impressions resembling *Phoenicopsis* and the trunk of a tree were reported by CROOKSHANK (1936) from Denwa sediments near Goari village. Recently, NANDI (1996) has recorded palynomorphs from the grey or carbonaceous shales in a Bore-hole ANH-1 (south of village Anhoni) at 100 and 200m depths and has dated it as Late Triassic (Carnian to Norian) age. Thus, the age of Denwa Formation is debatable unless more evidence is available. The present communication deals with the palynodating of this formation.

Stratigraphical Setting

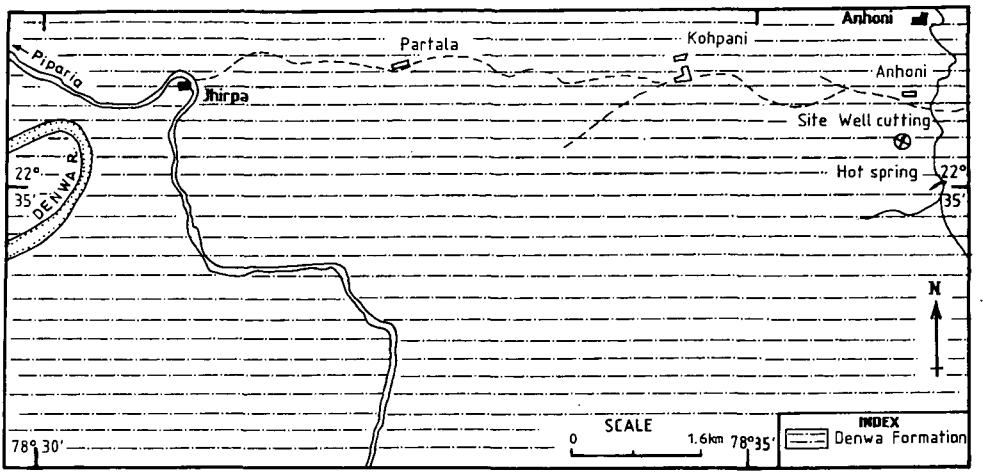
CROOKSHANK (1936) studied the geology of the area in detail. SASTRY et al. (1977), RAJA RAO (1983) have further detailed out the geological sequence as given in GSI Bulletin No. 45 (1983) Map No. 15.is summarised below : (in part).

Age	Formation	Lithology (thickness)
Lower Cretaceous	Jabalpur	
	Unconformity	
Rhaetian(?)	Bagra	Predominantly coarse conglomerates with bands of calcareous sandstone, variegated clays, limestone and dolomite (180 - 240 m)
	Unconformity	
Upper part of Lower Triassic to Middle Triassic	Denwa	Soft variegated clays interbedded with sandstone bands, conglomeratic at places (about 350 m)
Lower Triassic	Pachmarhi	White coarse-grained cross bedded sandstones with lenses of subangular quartz pebbles. (about 750 m)
Upper Permian	Bijori	Micaceous, flaggy sandstones and shales, at places micaceous

CROOKSHANK (1936) and RAJA RAO (1983) described that the Denwa Formation consists of mainly alternating beds of sandstones and variegated clays which are always calcareous and contain numerous calcareous (calcite) nodules and display a wide range of colours between green, red and buff, the red being most characteristic. SASTRY et al. (1977) and RAJA RAO (1983) believe that the Pachmarhi, Denwa and Bagra grade into one another laterally due to facies variation.

Materials and Methods

The rock samples for the present work have been collected from an artisan well south of the village Anhoni (22°36' : 78°35') Text-fig. 1.1. The material consisted seven samples of Khaki, yellow and Khaki green clays, of which four have yielded palynomorphs marked with an asterisk.



Text-fig. 1.1.

Geological map of Anhoni area. Showing well cutting sites (after CROOKSHANK, 1936).

Sequence of rocks samples investigated from Anhoni area, Satpura Basin

Sample Nos.	Rock types	Thickness of band (in meter)	Total depth (in meter)
8. Top	Coarse grained sandstone	06.30	06.30
7★	Khaki clay	00.30	06.60
	Sandstone	00.40	07.00
6★	Khaki clay	00.30	07.30
5	Khaki-yellow clay	00.20	07.50
	Maroon clay	00.80	08.30
	Sandstone yellow	01.70	10.00
	Maroon clay	01.20	11.20
4★	Khaki-green clay	00.30	11.50
	Sandstone	01.70	13.20
	Maroon clay	00.40	13.60
	Khaki clay	00.30	13.90
2	Maroon clay	02.30	16.20
	Yellow clay	00.30	16.50
	Sandstone yellow	01.50	18.00
Bottom	Yellow clay	00.20	18.20
	Sandstone yellow	00.70	18.90
	Yellow clay	00.20	19.10
	Sandstone yellow	?	?

Palynological composition

Haradisporites mineri SINGH and KUMAR 1972, *H. scabratus* KUMAR 1973
Osmundacidites sp.
Dictyophyllidites mortonii (DE JERSEY) PLAYFORD and DETTMANN 1965
Monolites anhoniensis KUMAR (Ms)
Alisporites indicus BHARADWAJ and SRIVASTAVA 1969, *A. ovalis* KUMAR 1973
★*Brachysaccus eskensis* DE JERSEY 1972, ★*B. ovalis* MÄDLER 1964, ★*B. indicus* KUMARAN and MAHESHWARI 1980.
★*Falcisporites australis* (DE JERSEY) HELBY 1973, ★*F. nidpurensis* (BHARADWAJ and SRIVASTAVA) KUMARAN and MAHESHWARI 1980, *F. stabilis* BALME 1970
Krempipollenites indicus TIWARI and VIJAYA 1995, *K. schaubergeri* (BHARADWAJ and TIWARI) TIWARI and VIJAYA 1995
★*Minutosaccus crenulatus* DOLBY 1976, ★*M. maedleri* KUMARAN and MAHESHWARI 1980
★*Samaropollenites speciosus* GOUBIN 1965
Satsangisaccites triassicus BHARADWAJ and SRIVASTAVA 1969, *S. royii* BHARADWAJ and SRIVASTAVA 1969
Scheuringipollenites tentulus (TIWARI) TIWARI 1973
Staurosaccites minutus KUMARAN and MAHESHWARI 1980, ★*S. ovalis* KUMARAN and MAHESHWARI 1980
Guttulapollenites hannoniens GOUBIN 1965
Faunipollenites varius BHARADWAJ 1962, *F. bharadwajii* MAHESHWARI 1967
Striatopodocarpites dubrajpurensis TRIPATHI, TIWARI and KUMAR 1990, *S. nidpurensis* BHARADWAJ and SRIVASTAVA 1969
Arcuatipollenites ovatus (GOUBIN) TIWARI and VIJAYA 1995, *A. pellucidus* (GOUBIN) TIWARI and VIJAYA 1995
Callialasporites sp.
★*Cycadopites* cf. *stonei* HELBY 1987, *C.* sp.
Corollina cf. *simplex* (MALJAVKINA) VENKATACHALA and GÓCZÁN 1964
Laricoidites sp.
★*Aratrisporites fischeri* (KLAUS) PLAYFORD and DETTMANN 1965
Striatites cancellatus (BALME and HENNELLY) POTONIÉ 1958
Protohaploxypinus sp.
★*Rimaesporites potoniei* LESCHIK 1955
Fungal remains
Dinocyst Type - A, D. Type - B

Palynoassemblage

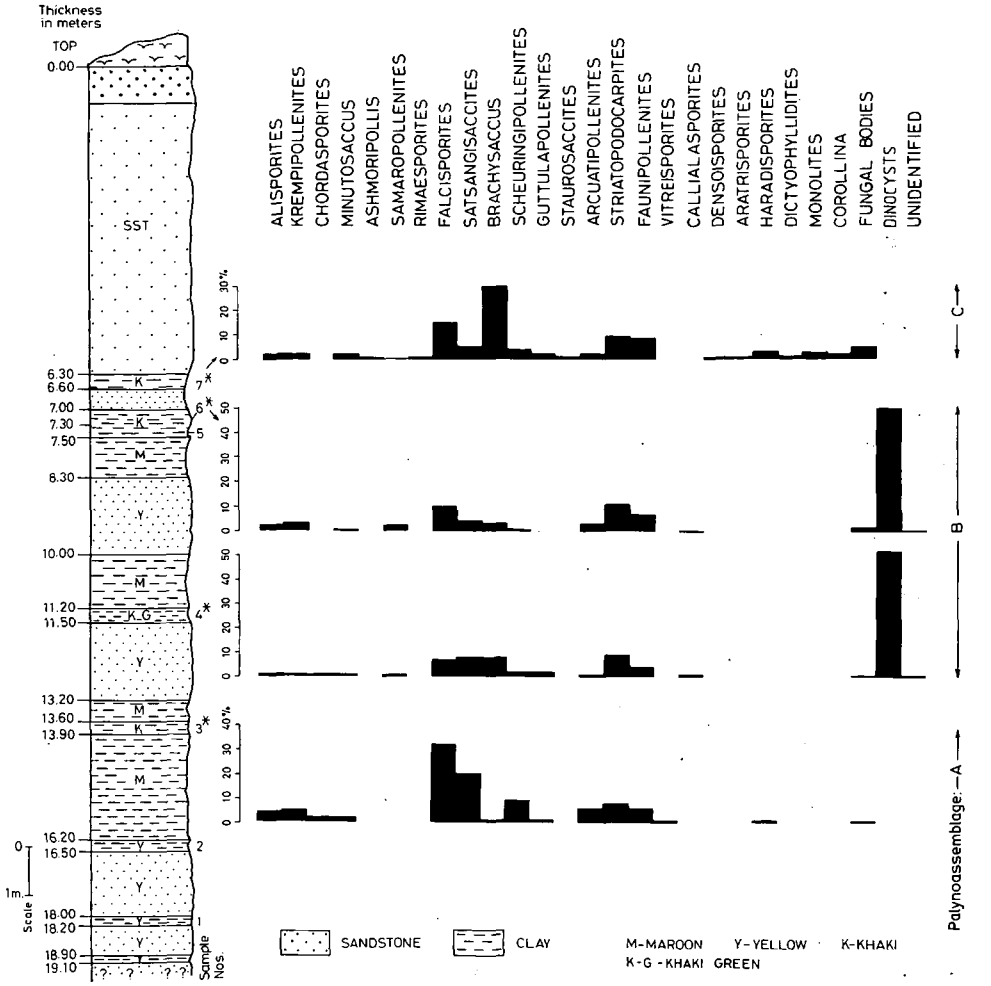
The palynoassemblage of sediments exposed in a well section near Anhoni village belonging to Denwa Formation comprises 25 genera and 39 species, of which *non-striate disaccate* are prominent followed by *striated disaccate* pollen. The *pteridophytic* spores are poorly represented in the assemblage. The percent frequencies have been shown in Text-fig. 1.2. The sample no. 3 (lower in the sequence) contains dominance of *Falcisporites* and *Satsangisaccites*. The samples nos. 4 and 6 possess dominance of *"Dinocysts"* but pollen and spores are rather fair to poor in occurrence. The sample no. 7 (top) has the dominance of *Brachysaccus* followed by *Falcisporites*. The characteristic

forms appeared in the assemblage are *Haradisporites, Monolites, Minutosaccus, Cycadopites, Ashmoripollis, Staurosaccites, Aratrisporites, Corollina, Samaropollenites* etc. which are new to the assemblage. Thus three palynoassemblages are differentiated.

Palynoassemblage - A (Sample no. 3) has *Falcisporites, Satsangisaccites, Minutosaccus.*

Palynoassemblage - B (Samples nos. 4 and 6) have *Dinocysts, Falcisporites, Satsangisaccites, Brachysaccus, Samaropollenites.*

Palynoassemblage - C (Sample no. 7) has *Brachysaccus, Falcisporites, Ashmoripollis, Corollina, Monolites.*



Text-fig. 1.2.

Palynostratigraphy of Denwa Formation, south of Anhoni village, Satpura Basin.

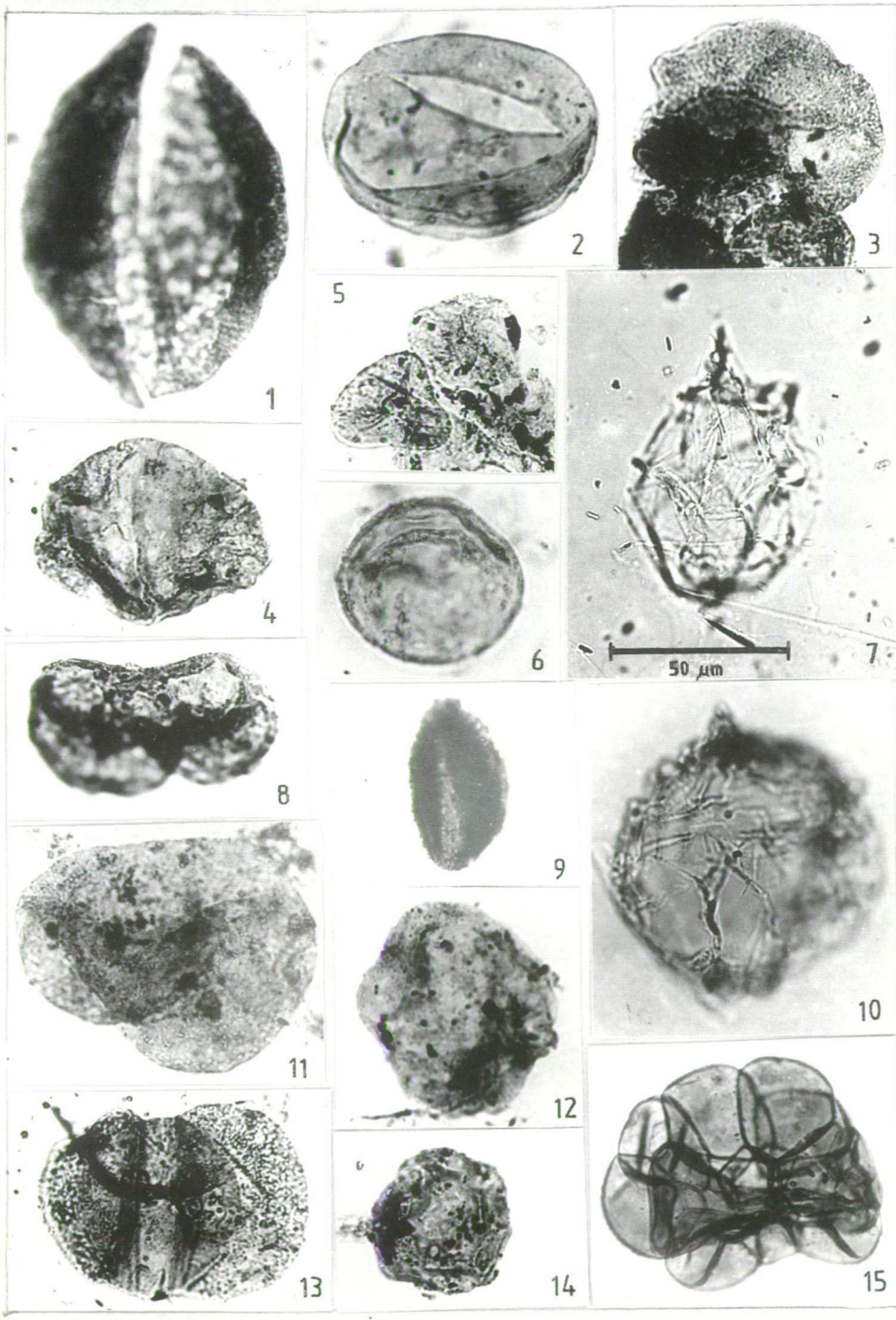


Plate 1.1

Status of the present assemblage in the Satpura Basin

The Mahadeva Group in Satpura Basin consists of mainly three units (Formations) viz. Pachmarhi, Denwa and Bagra. The palynoassemblage from the Pachmarhi Formation have been described by KUMAR (1995, 1996) which has the dominance of *Falcisporites* followed by *Satsangisaccites*. The characteristic forms of the assemblage were *Goubinispora, Staurosaccites, Playfordiaspora, Lundbladispora* and *Densoisporites,* etc. The presently studied assemblage of Denwa Formation contains only *Staurosaccites* (in sample no. 7) whereas the sample no. 3 is comparable in having the dominance of *Falcisporites* and *Satsangisaccites*. Samples nos. 4 and 6 do not compare with Pachmarhi Formation assemblage as they contain dominance of *Dinocysts* and the occurrence of *Brachysaccus, Minutosaccus* and *Samaropollenites* which indicate a younger aspect. Sample no. 7 (top in sequence) contains dominance of *Brachysaccus* followed by *Falcisporites - Satsangisaccites.* This also contains *Monolites, Ashmoripollis, Rimaesporites, Aratrisporites, Corollina* and *Haradisporites* further indicates towards the younger aspect. NANDI (1996) recorded palynoassemblages I at 100 m depth and II at 200 m depth (Late Triassic) in the Anhoni region, which have the dominance of *Falcisporites* (± 27%) followed by *Satsangisaccites* (± 14%). The presence of *Brachysaccus* (± 3%), *Minutosaccus* (± 2%) *Samaropollenites* (± 5%), *Aratrisporites* (± 2%) and *Staurosaccites* (± 2%) compares with the presently described assemblages. However, *Haradisporites, Monolites, Ashmoripollis* and *Corollina* are not present in the palynoassemblage I and II described by NANDI. There is no palynological record from the Bagra Formation (Rhaetic ?) of Satpura Basin till date.

Comparison with other palynoassemblages

Palynoassemblages have been recorded from Nidpur and Gopad River, South Rewa Basin by BHARADWAJ and SRIVASTAVA (1969), TIWARI and RAM-AWATAR (1990, 1992) dated as Early Triassic - Middle Triassic based on prominance of *Satsangisaccites, Nidipollenites, Weylandites.* TIWARI and RANA (1980) assigned Nidpur palynoassemblage of BHARADWAJ and SRIVASTAVA (1969) to Upper Triassic (Carnian age) in

Plate 1.1.

1. *Brachysaccus indicus* KUMARAN and MAHESHWARI 1979.
2. *Monolites anhoniensis* KUMAR (Ms)
3. *Aratrisporites fischeri* (KLAUS) PLAYFORD and DETTMANN 1965.
4. *Minutosaccus maedleri* KUMARAN and MAHESHWARI 1979.
5. *Haradisporites scabratus* SINGH and KUMAR 1973.
6. *Corollina cf. simplex* (MALJAVKINA) VENKATACHALA and GÓCZÁN 1964.
7. *Dinocyst* Type - A.
8. *Rimaesporites potoniei* LESCHIK 1955.
9. *Cycadopites* cf. *stonei* HELBY 1987.
10. *Dinocyst* Type - B.
11. *Samaropollenites speciosus* GOUBIN 1965.
12. *Ashmoripollis reducta* HELBY 1987.
13. *Krempipollenites indicus* TIWARI and VIJAYA 1995.
14. *Callialasporites* sp.
15. Fungal hyphae/fungal spore in a group.

All photomicrograph are magnified 500x unless and otherwise stated scale given in fig. 7.

having *Weylandites, Satsangisaccites, Praecolpatites, Nidipollenites, Alisporites, Klausipollenites.* MAHESHWARI and KUMARAN (1979) and KUMARAN and MAHESHWARI (1980) described palynofossils from Tiki Formation (Carnian - Norian age) exposed in Son River and Janar Nala Sections, South Rewa Gondwana Basin. Palynoassemblage from Tharipathar had dominance of *Samaropollenites* and *Protohaploxypinus* which are poorly present in the studied assemblage. The dominant element *Rimaesporites* of Ghiar section is poorly known here on the other hand both have some characteristic forms: *Aulisporites, Accintisporites, Triradispora, Duplicisporites* etc. which are absent in the Anhoni assemblage. The present assemblage has *Ashmoripollis, Corollina* and *Monolites* which are absent in the Tiki palynoassemblages whereas *Brachysaccus* is present in dominance in Denwa Formation studied here.

TIWARI et al. (1984) described palynoassemblages A - F from Bore core RJR-2, Kazigaon in Rajmahal Basin. Palynoassemblage - A belonging to Dubrajpur Formation has dominance of *Satsangisaccites* (included here *Falcisporites*) as also seen in sample no. 3 of Anhoni assemblage but the absent of *Rajmahalispora, Nidipollenites, Lundbladispora, Playfordiaspora, Goubinispora* in the present assemblage indicate a different composition. The palynoassemblages B and C of Rajmahal Basin closely compare with the Anhoni assemblage (Sample no. 7) in having dominance of *Brachysaccus, Satsangisaccites* and the presence of *Minutosaccus. Samaropollenites* but the former differs from the latter in having *Infernopollenites, Lundbladispora, Playfordiaspora, Nidipollenites.* The Anhoni assemblage differs from Rajmahal palynoassemblages in having *Ashmoripollis, Aratrisporites, Corollina, Monolites* and *Cycadopites.*

PRASAD and JAIN (1994) recorded four palynoassemblages D - A (Smithian - Norian respectively) in the subsurface at Kommugudem and Mandapeta areas, Krishna-Godavari Basin. The present Anhoni assemblage is comparable to palynoassemblage - A *Minutosaccus crenulatus* zone of Krishna-Godavari in having *Ashmoripollis, Staurosaccites, Brachysaccus* and *Cycadopites stonei* Carnian-Norian age. Recently, PRASAD (1997) reported palynofossils from Early, Middle and Late Triassic sediments in deep bore cores at Kommugudem - A and Mandapeta - A,C and D wells in the Krishna-Godavari Basin. The Anhoni palynoassemblage compares with the *Minutosaccus crenulatus* zone-I of K-G Basin but the latter differs from the former assemblage in having *Ceratosporites, Duplicisporites, Voltziaceaesporites, Dubrajisporites, Enzonalasporites, Camerosporites, Ovalipollis* and *Zebrasporites* which are absent in Anhoni. On the contrary the Anhoni palynoassemblage possesses *Brachysaccus* in dominance (Sample no. 7) and shows appearance of *Corollina* and *Rimaesporites, Ashmoripollis* and *Haradisporites.*

LUKOSE and MISRA (1980) reported a Late Triassic palynofossils in the subsurface sediments drilled at Jaisalmer Basin, Rajasthan. The palynoflora contains *Samaropollenites, Staurosaccites, Ovalipollis, Camerosporites.* The latter two forms are absent here, hence it differs from the studied assemblage. The Late Triassic (Rhaeto-Liassic) palynoflora recorded in Banni well No. B in Kutchch Basin comprises the dominance of *Gliscopollis* and *Rhaetipollis* which are lacking here. Hence the Anhoni palynoassemblage recovered from Denwa Formation in Satpura Basin indicate an older aspect.

HELBY et al (1987) recorded palynological zones in the Mesozoic sediments of western Australia. They formed *Falcisporites* Super Zone in which *Ashmoripollis reducta* Oppel Zone from Carnorvon Basin has been instituted and the occurrence of *Corollina* spp. suggested Rhaetian age. They have also instituted *Minutosaccus crenulatus* Oppel Zone (DOLBY and BALME, 1976) HELBY et al. (1987) which also contains *Dictyophyllidites, Cycadopites stonei* assigned to Carnian to Norian age. The Anhoni assemblage

compares well with the *Falcisporites* Super Zone of Carnorvon Basin particularly Oppel Zones *Minutosaccus crenulatus* and *Ashmoripollis reducta* Norian to Rhaetian.

Conclusions

1. The palynoassemblage recorded from the sediments exposed in a welled section near Anhoni pertains to Denwa Formation in Satpura Basin and shows dominance of *Falcisporites* and *Brachysaccus.*

2. Sample nos. 4 and 6 contain dominance of *Dinocysts* while *non-striate disaccate Falcisporites, Satsangisaccites* and *Brachysaccus* are common elements.

3. Sediments at the top of the sequence (Sample no. 7) possesses the prominence of *Brachysaccus* followed by *Falcisporites, Satsangisaccites* but the appearance of younger elements *Corollina, Ashmoripollis, Monolites* and *Haradisporites* indicates Norian - Rhaetian age.

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2. ORGANIC MICROFOSSILS FROM HUNGARIAN CRETACEOUS SEDIMENTS

M. KEDVES

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

This paper deals with the LM results of the organic microfossils isolated from Hungarian Cretaceous sediments from the following three localities: Lippó, Boly and Bácsalmás. The results and the evaluation of the data is presented by the different localities.

Key words: Palynology, fossil, Cretaceous, Hungary.

Introduction

There are several publications concerning the spore-pollen assemblages of the Cretaceous layers of Hungary. The most important papers are as follows; Lower/Middle Cretaceous: the fundamental works were published by DEÁK (1961, 1962, 1963, 1964a,b, 1965), further papers by JUHÁSZ (1972, 1975, 1977a,b,c, 1979a,b, 1980, 1983a,b), and JUHÁSZ and GÓCZÁN (1976). Upper Cretaceous: GÓCZÁN (1961, 1963, 1964a,b, GÓCZÁN, GROOT, KRUTZSCH, and PACLTOVÁ (1967), GÓCZÁN et al. (1986), GÓCZÁN and SIEGL-FARKAS (1989, 1990), SIEGL-FARKAS (1984, 1986, 1988, 1993a,b), SIEGL-FARKAS and KEDVES (1995), KEDVES (1983, 1984), KEDVES and DINIZ (1983). The global paleophytogeographical problems of the Senonian were discussed by KEDVES (1985). Within Europe this problem was investigated in particular by KEDVES and DINIZ (1983). The pecularities of the *Eunormapolles* assemblages of the Carpathian Basin were discussed in comparison to the Iberian ones in the first place to the assemblages of Portugal.

The aim of this paper is to present the whole organic material of the samples for investigation. Based on the organic microfossil data we try to get paleoecological conclusions to compare with the Hungarian and European Cretaceous spore-pollen assemblages. In this respect the data of spore-pollen published by SIEGL-FARKAS (1986) from samples of the bore-hole Bácsalmás I. are noteworthy.

Materials and Methods

Lippó-1 bore-hole. Five limestone samples were investigated from the following depths: L-1-1, 753.0-1173.0 m., L-1-2, 1187.3-1632.0 m., L-1-3, 1655.8-1656.0 m., L-1-4, 1673.85-1674.1 m., L-1-5, 1690.1-1999.2 m.

Boly-I bore-hole. Twelve samples were the subject of our investigations from the following depths: 600.72-600.05 m., 612.80 m., 671.05 m., 730.55 m., 730.70 m., 831.00 m., 892.00 m., 951.00 m., 1023.00 m., 1088.00 m., 1131.20 m., 1170.80 m.

Bácsalmás-I bore-hole. Eleven samples were investigated: 607.10-607.20 m., 616.60-616.65 m., 627.00-627.05 m., 644.35-644.65 m., 653.50-653.55 m., 663.90-664.00 m., 674.80-674.85 m., 685.60-685.70 m., 692.20-692.30 m., 1192.30 m., 1194.60 m.

The samples were limestone, in general 1000 g material was treated by samples. When we had not enough material at least about 500 g was the starting quantity.

Results

1. LIPPÓ-1 BORE-HOLE

Tissue remnants. - Secondary xylem remnants are relatively common in the slides investigated (Plate 2.1., figs. 1-3, 5-8), but in a poor preservation. The type of pits is a modern *gymnosperm*. The detailed results of the samples investigated may be summarized as follows:

Lippó-1-1. - The quantity of the tissue remnants is high, with few *Mycophyta* spores. Some *angiosperm* pollen grains were observed which are in a poor preservation: *Psilatricolporites* fsp., *Normapolles* fgen et fsp. indet., Cf. *Triatriopollenites* fsp.

Lippó-1-2. - A great quantity of degraded tissue remnants (Plate 2.1., fig. 4), and one pollen grain type (cf. *Interporopollenites guineti* KEDVES et HEGEDÜS 1975) was observed (Plate 2.1., figs. 9,10).

Lippó-1-3. - The amorphous black organic remnants are in a high quantity with few xylem and epidermis fragments. Some inaperturate microfossils were also observed.

Lippó-1-4. - The occurence of the inaperturate forms is relatively high together with the dark tissue remnants.

Lippó-1-5. - This sample is rich in amorphous organic remnants, some fragments of *gymnosperm* tracheids also occurred.

The few data indicate Senonian age for these samples.

2. BOLY-I BORE-HOLE

Chinitinous *Foraminiferae* shells are common in the samples investigated. Based on the work of DEÁK (1964a) *Trochiliascia cuvillieri* DEÁK 1964a was observed. (Plate 2.1., fig. 11). Similar microfossil was published later by COURTINAT and MÉON (1991) as "Morphotype TS 1". Following TAPPAN and LOEBLICH (1965) as affinity the *Globigerinelloides* was given. Occurrences from the Berriasian until the Campanian-Maestrichtian were established by COURTINAT and MÉON (1991). Regarding the tissue remnants there are well preserved fragments such as *angiosperm* vessels (Plate 2.1., fig. 12), and *gymnosperm* tracheids. Epidermis with *Gramineae* type stoma also occurred (Plate 2.1., fig. 13, plate 2.2., fig. 1). Salt water conditions indicating *Hystrichosphaeridae* were observed on the top and on the basis of the section investigated (Plate 2.2., figs. 2-7). Sporomorphs occurred in all of the samples investigated in a relatively good preservation.

List of the observed organic microfossils:

Hystrichosphaeridae

Hystrichoshaeridium cf. *recurvatum* (WHITE 1842) DAVEY et WILLIAMS 1966 (Plate 2.2., figs. 2,3), *Amphorosphaeridium fenestratum* DAVEY 1969 (Plate 2.2., figs. 4,5),

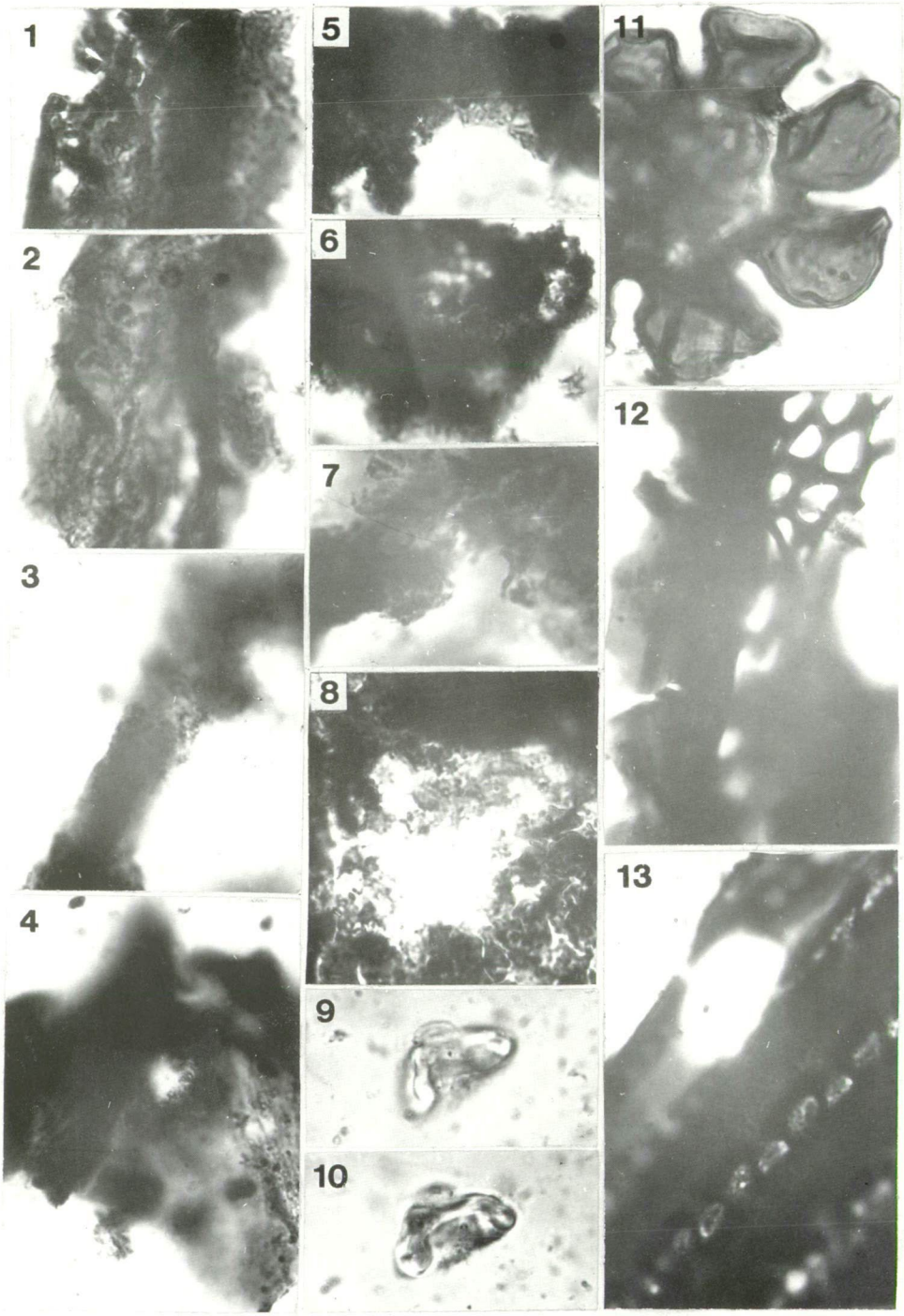

Plate 2.1.

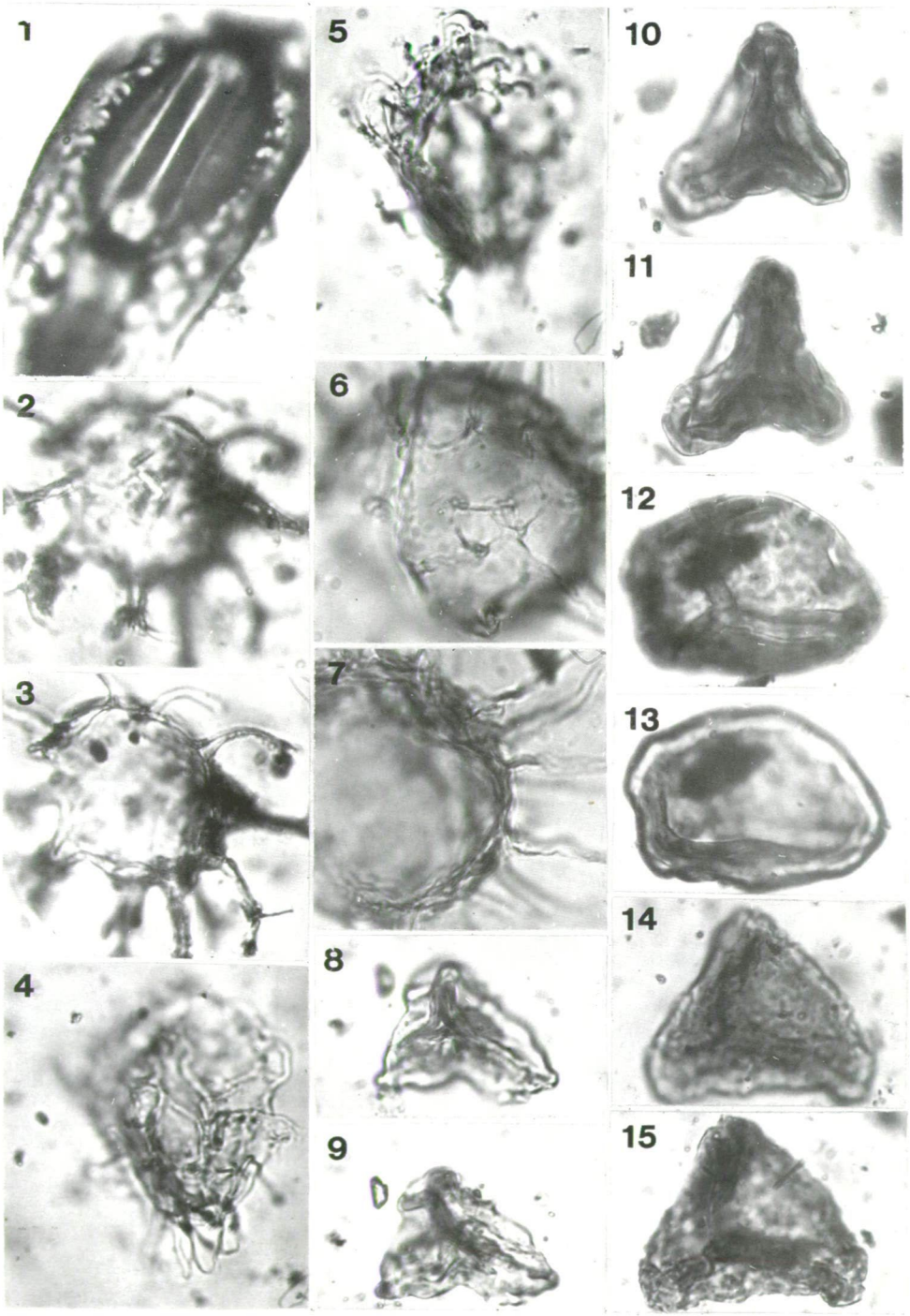

Plate 2.2.

Lingulodinium machaerophorium (DEFLANDRE et COOKSON 1955) WALL 1967 (Plate 2.2., figs. 6,7).

Sporites

Matonisporites elegans HUNT 1985 (Plate 2.2., figs. 10,11), Cf. *Trilites* fsp., (Plate 2.2., figs. 12,13), *Clavifera* fsp. 1, *Gleicheniaceae* (Plate 2.2., figs. 8,9), *Clavifera* fsp. 2, (Plate 2.3., figs. 11,12), Cf. *Ornamentifera* fsp., (Plate 2.2., figs. 14,15), cf. *Klukisporites pseudoreticulatus* COUPER 1958 (Plate 2.3., figs. 3,4), *Cicatricosisporites furcatus* DEÁK 1963, *Schizaeaceae* (Plate 2.3., figs. 5,6), *Cicatricosisporites* fsp. 1, *Schizaeaceae*, (Plate 2.3., figs. 1,2), *Cicatricosisporites* fsp. 2, *Schizaeaceae* (Plate 2.3., figs. 7,8).

Pollenites

Gymnosperm pollen grains

Vitreisporites pallidus (REISSINGER 1950) NILSSON 1958 (Plate 2.3., figs. 9,10).

Angiosperm pollen grains

Normapolles

Oculopollis minoris KRUTZSCH 1973 (Plate 2.3., figs. 13,14), *Interporopollenites rugulus* KEDVES et HEGEDÜS 1975 (Plate 2.3., figs. 15,16), *Normapolles* massula (Plate 2.3., figs. 17,18).

Postnormapolles

Labraferoidaepollenites rurensis (PFLUG et THOMSON 1953) KEDVES 1982 in KEDVES et RUSSELL, *Myricaceae* (Plate 2.3., figs. 19,20), *Alabroidaepollenites convexus* KEDVES 1982 in KEDVES et RUSSELL, *Myricaceae* (Plate 2.3., figs. 21,22).

The quantity of the plant microfossils is not enough for a paleoecological evaluation, but the following may be pointed out:

Plate 2.1.

Magnification of all microphotographs are 1000x.

1. Degraded *gymnosperm* xylem fragment; slide: Lippó-1-5-1, cross-table number: 14.9/143.8.
2. Degraded *gymnosperm* xylem fragment; slide: Lippó-1-3-2, cross-table number: 16.2/139.1.
3. Extremely degraded xylem remnant; slide: Lippó-1-4-3, cross-table number: 16.3/129.8.
4. Degraded cuticule fragment; slide: Lippó-1-2-3, cross-table number: 22.7/142.1.
5. Degraded xylem remnant; slide: Lippó-1-4-3, cross-table number: 18.5/138.9.
6. Degraded xylem remnant; slide: Lippó-1-4-3, cross-table number: 24.9/142.8.
7. Degraded xylem remnant; slide: Lippó-1-4-3, cross-table number: 22.4/136.6.
8. Degraded xylem remnant; slide: Lippó-1-5-2, cross-table number: 23.2/133.2.

9,10. Cf. *Interporopollenites guineti* KEDVES et HEGEDÜS 1975; slide: Lippó-1-2-1, cross-table number: 14.5/132.7.

11. *Trochiliascia cuvillieri* DEÁK 1964a; slide: Boly I, 0/2-4, cross-table number: 8.3/148.7.
12. *Angiosperm* vessel fragment; slide: Boly I, 0/2-3, cross-table number: 6.6/144.9.
13. Epidermis fragment of "*Gramineae* type"; slide: Boly I, 0/10-2, cross-table number: 9.8/147.5.

Plate 2.2.

1. Stoma remnant of "*Gramineae* type"; slide: Boly I, 0/4-4, cross-table number: 12.4/143.6.

2,3. *Hystrichosphaeridium* cf. *recurvatum* (WHITE 1842) DAVEY et WILLIAMS 1966; slide: Boly I, 0/12-1, cross-table number: 18.2/141.1.

4,5. *Amphorosphaeridium fenestratum* DAVEY 1969; slide: Boly I, 0/11-3, cross-table-number: 12.9/140.6.

6,7. *Lingulodinium machaerophorium* (DEFLANDRE and COOKSON 1955) WALL 1967; slide: Boly I, 0/12-3, cross-table number: 9.3/132.9.

8,9. *Clavifera* fsp., *Gleicheniaceae*; slide: Boly I, 0/5-5, cross-table number: 7.1/131.2.

10,11. *Matonisporites elegans* HUNT 1985; slide: Boly I, 0/11-2, cross-table number: 17.3/149.1.

12,13. Cf. *Trilites* fsp.; slide: Boly I, 0/11-2, cross-table number: 9.9/128.4.

14,15. Cf. *Ornamentifera* fsp., *Gleicheniaceae*; slide: Boly I, 0/9-3, cross-table number: 12.8/128.7.

1. The quantity of the plant tissue remnants is relatively high in all the samples investigated.
2. *Normapolles* pollen grains are represented also in all the samples investigated richer spore-pollen assemblage.

3. BÁCSALMÁS-I BORE-HOLE

General establishments:
1. Chitinous *Foraminiferae* shells (*Scytinascia*) occurred in the greatest part of the samples investigated.
2. The plant tissue remnants are relatively well preserved; *angiosperm* xylem fragment (Plate 2.3., figs. 23,24) and epidermis remnant of *dicotyledonous* type was also observed (Plate 2.4., fig. 1).
3. *Hystrichosphaeridae* occurred in the greatest part of the samples investigated except the lower sample (1194.60 m.). The preservation of these remnants is quite good.
4. *Botryococcus* colonies occurred sporadically.

The observed organic microfossils:
Algae
Chlorophyceae: Botryococcus sp. (Plate 2.4., figs. 8,9)
Hystrichosphaeridae
Hystrichosphaera ramosa (EHRENBERG 1838) O. WETZEL 1932 var. *ramosa* DAVEY et WILLIAMS 1966 (Plate 2.4., figs. 2,3), cf. *Micrhystridium gracile* DEÁK et COMBAZ 1967 (Plate 2.4., figs. 4,5), *Spiniferites splendidus* HARLAND 1979 (Plate 2.4., figs. 6,7).
Sporites
Vadaszisporites urkuticus DEÁK (1964b) DEÁK et COMBAZ 1967 (Plate 2.4., figs. 10,11).
Pollenites
Angiosperm pollen grains
Longaxones
Corroded pollen grains of "*quisqualis*" and "*oviformis*" type.
Normapolles
Cf. *Trudopollis* fsp. (Plate 2.4., figs. 12,13), *Semioculopollis daniensis* KEDVES 1979 (Plate 2.5., figs. 1,2), *S. croxtonae* KEDVES 1979 (Plate 2.5., figs. 3,4), *Oculopollis minoris* KRUTZSCH 1973 (Plate 2.5., figs. 5-14), *Papillopollis cf. cretacicus* KEDVES et PITTAU 1979, *cf. Druggipollenites* fsp. (Plate 2.5., figs. 17,18), *Interporopollenites* cf. *initium* (PFLUG 1953a) PFLUG 1953b (Plate 2.5., figs. 21,22), *I. triangulus* KEDVES et HEGEDÜS 1975 (Plate 2.5., figs. 23,24), *I. guineti* KEDVES et HEGEDÜS 1975 (Plate 2.5., figs. 25,26).
Postnormapolles
Triatriopollenites minimus (GLADKOVA 1965) KEDVES 1974, *Juglandaceae, Engelhardtia* (Plate 2.5., figs. 19,20), *Subtriporopollenites constans* PFLUG 1953a *subfsp. crassiexinus* KEDVES 1970, *?Juglandaceae* (Plate 2.5., figs. 27,28).

The quantitative data will be discussed by the formations established by JOCHA-EDELÉNYI and HAAS published by SIEGL-FARKAS (1986):
1. Bácsalmás Formation
Madaras Sandstone Section

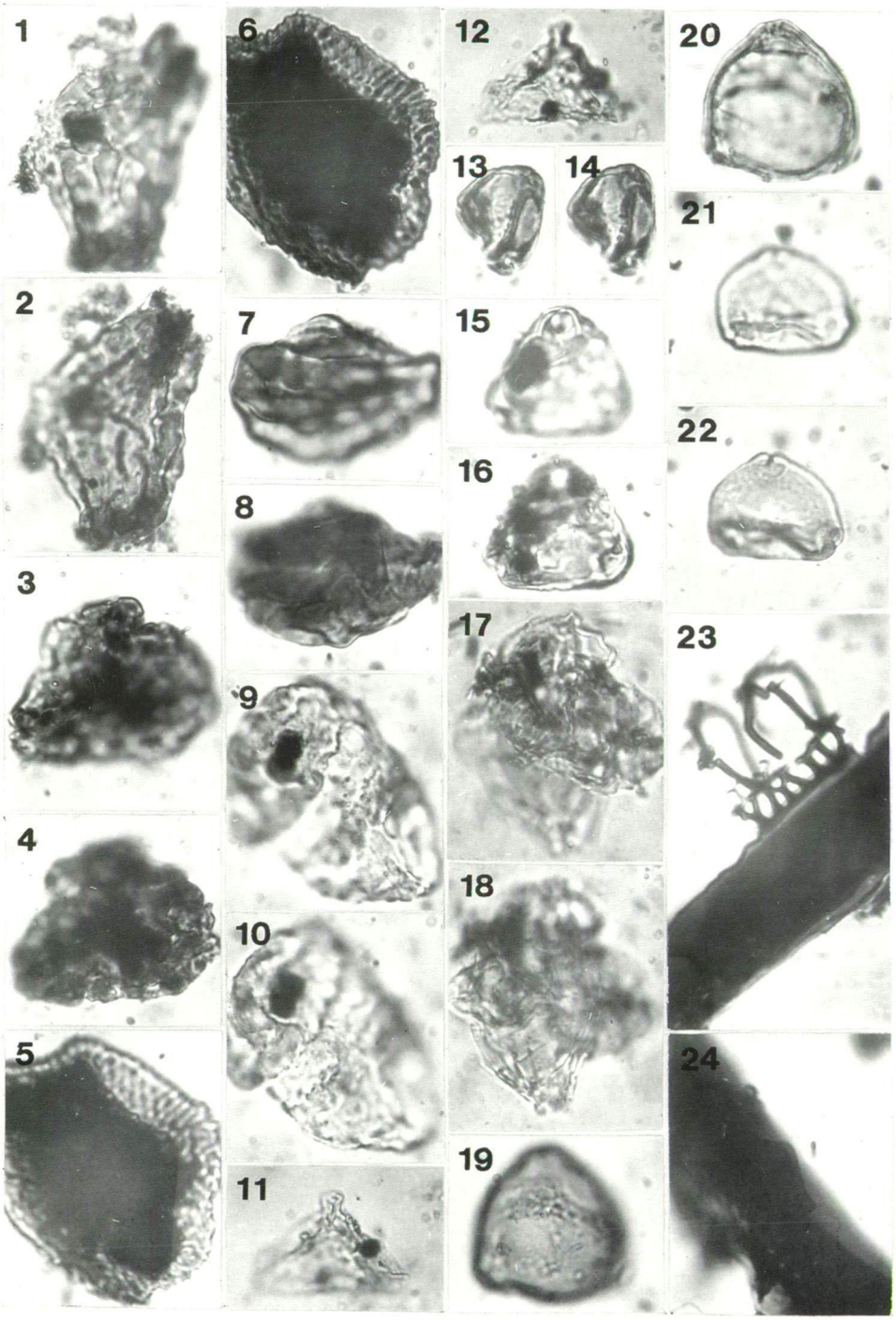

Plate 2.3.

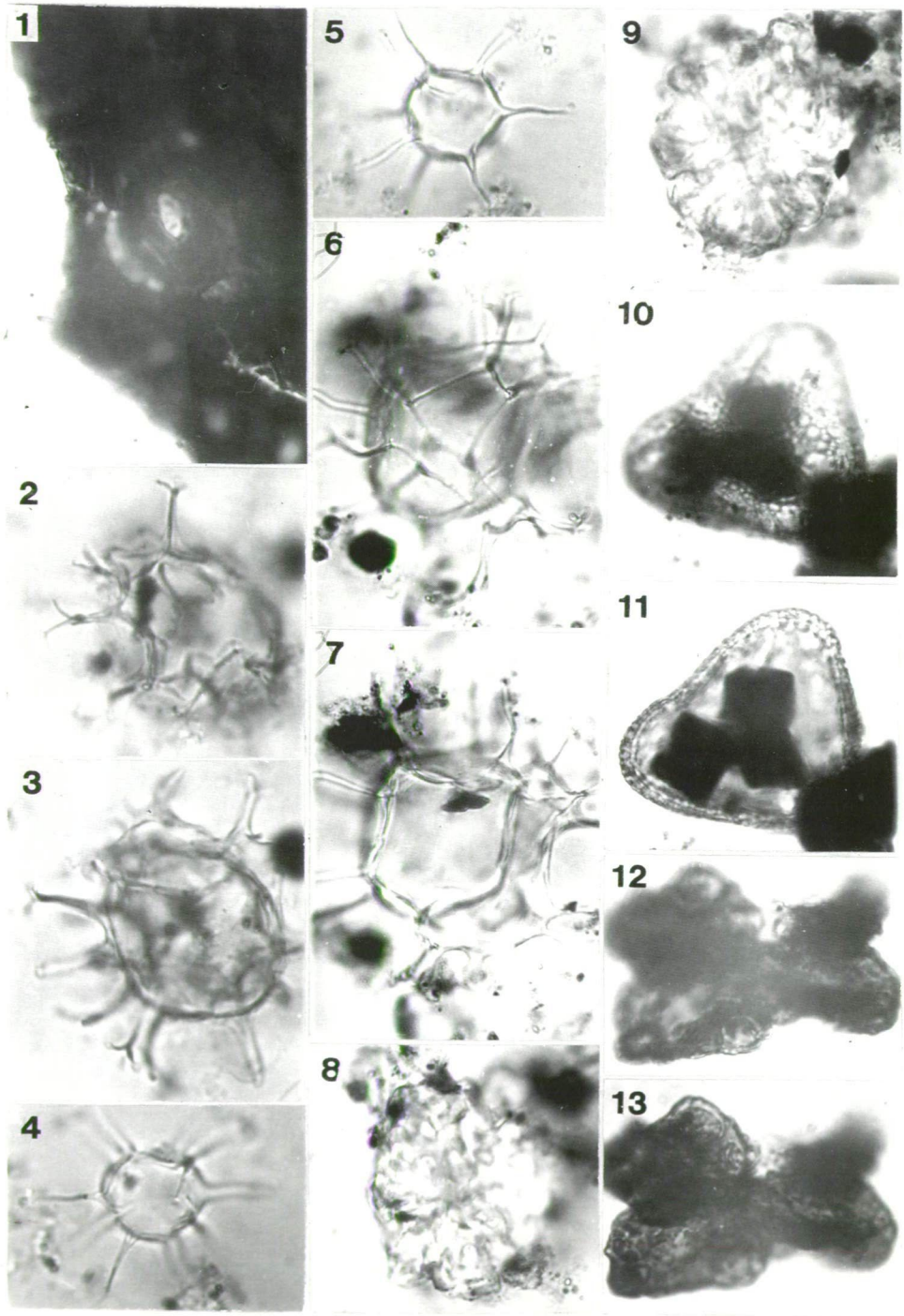

Plate 2.4.

Hystrichosphaeridae and *Scytinascia* occurred with plant tissue remnants. *Longaxones* (*oviformis* and *quisqualis* type) and among the *Brevaxones, Normapolles* taxa occurred in a few quantity.

Csávoly Marl Section

The occurrence of the *Hystrichosphaeridae* and the *Scytinascia* is characteristic. *Botryococcus* colonies occurred in a small quantity. The most important characteristic is the relatively richness of the *Normapolles* taxa.

Marl with bulbous limestone and antigenous brecca.

Similarly to the previous section the occurrence of the salt water indicating remains is important together with the *Normapolles* taxa indicating the Senonian age.

2. Csikéria Marl Formation was not investigated during this research program.

3. Ágasegyháza Pebble Formation

Following the paper of SIEGL-FARKAS (1986) this formation is represented by the sediments from 793.0-816.3 m. We have investigated two samples below this depth: 1192.30 m., and 1194.6 m. These layers preserved some organic microfossils in a poor preservation (*Hystrichosphaeridae, tricolpate* form, *Normapolles* taxa).

Plate 2.3.

1,2. *Cicatricosisporites* fsp. 1, *Schizaeaceae*; slide: Boly I, 0/7-4, cross-table number: 8.5/143.7.
3,4. Cf. *Klukisporites pseudoreticulatus* COUPER 1958; slide: Boly I, 0/10-4, cross-table number: 24.1/132.7.
5,6. *Cicatricosisporites furcatus* DEÁK 1963, *Schizaeaceae*, cf. *Anemia*; slide: Boly I, 0/11-5, cross-table number: 10.1/146.2.
7,8. *Cicatricosisporites* fsp. 2, *Schizaeaceae*; slide: Boly I, 0/10-4, cross-table number: 16.7/143.1.
9,10. *Vitreisporites pallidus* (REISSINGER 1950) NILSSON 1958; slide: Boly I, 0/10-2, cross-table number: 15.2/139.1.
11,12. *Clavifera* fsp., *Gleicheniaceae*; slide: Boly I, 0/3-3, cross-table number: 22.6/131.6.
13,14. *Oculopollis minoris* KRUTZSCH 1973; slide: Boly I, 0/21-1, cross-table number: 19.2/147.7.
15,16. *Interporopollenites rugulus* KEDVES et HEGEDÜS 1975; slide: Boly I, 0/12-1, cross-table number: 8.2/135.0.
17,18. *Normapolles* massula; slide: Boly I, 0/10-4, cross-table number: 12.4/131.5.
19,20. *Labraferoidaepollenites rurensis* (PFLUG et THOMSON 1953) KEDVES 1982 in KEDVES et RUSSELL, *Myricaceae*; slide: Boly I, 0/4-2, cross-table number: 11.4/130.9.
21,22. *Alabroidaepollenites convexus* KEDVES 1982 in KEDVES et RUSSELL, *Myricaceae*; slide: Boly I, 0/6-2, cross-table number: 10.7/131.2.
23,24. *Angiosperm* vessel fragment; slide: Bácsalmás-I, 0/22-4, cross-table number: 16.0/146.5.

Plate 2.4.

1. Carbonified epidermis remnant with a stoma; slide: Bácsalmás-I, 0/16-1, cross-table number: 18.7/136.6.
2,3. *Hystrichosphaera ramosa* (EHRENBERG 1938) O. WETZEL 1932 var. *ramosa* DAVEY and WILLIAMS 1966; slide: Bácsalmás-I, 0/20-2, cross-table number: 23.1/140.0.
4.5. Cf. *Micrhystridium gracile* DEÁK et COMBAZ 1967; slide: Bácsalmás-I, 0/20-1, cross-table number: 14.2/145.3.
6,7. *Spiniferites splendidus* HARLAND 1979; slide: Bácsalmás-I, 0/17-1, cross-table number: 9.2/132.3.
8,9. *Botryococcus* sp.; slide: Bácsalmás-I, 0/16-4, cross-table number: 16.2/132.2.
10,11. *Vadaszisporites urkuticus* (DEÁK 1964) DEÁK et COMBAZ 1967; slide: Bácsalmás-I, 0/17-2, cross-table number: 26.8/142.2.
12,13. Cf. *Trudopollis* fsp., massula; slide: Bácsalmás-I, 0/21-3, cross-table number: 20.2/137.5.

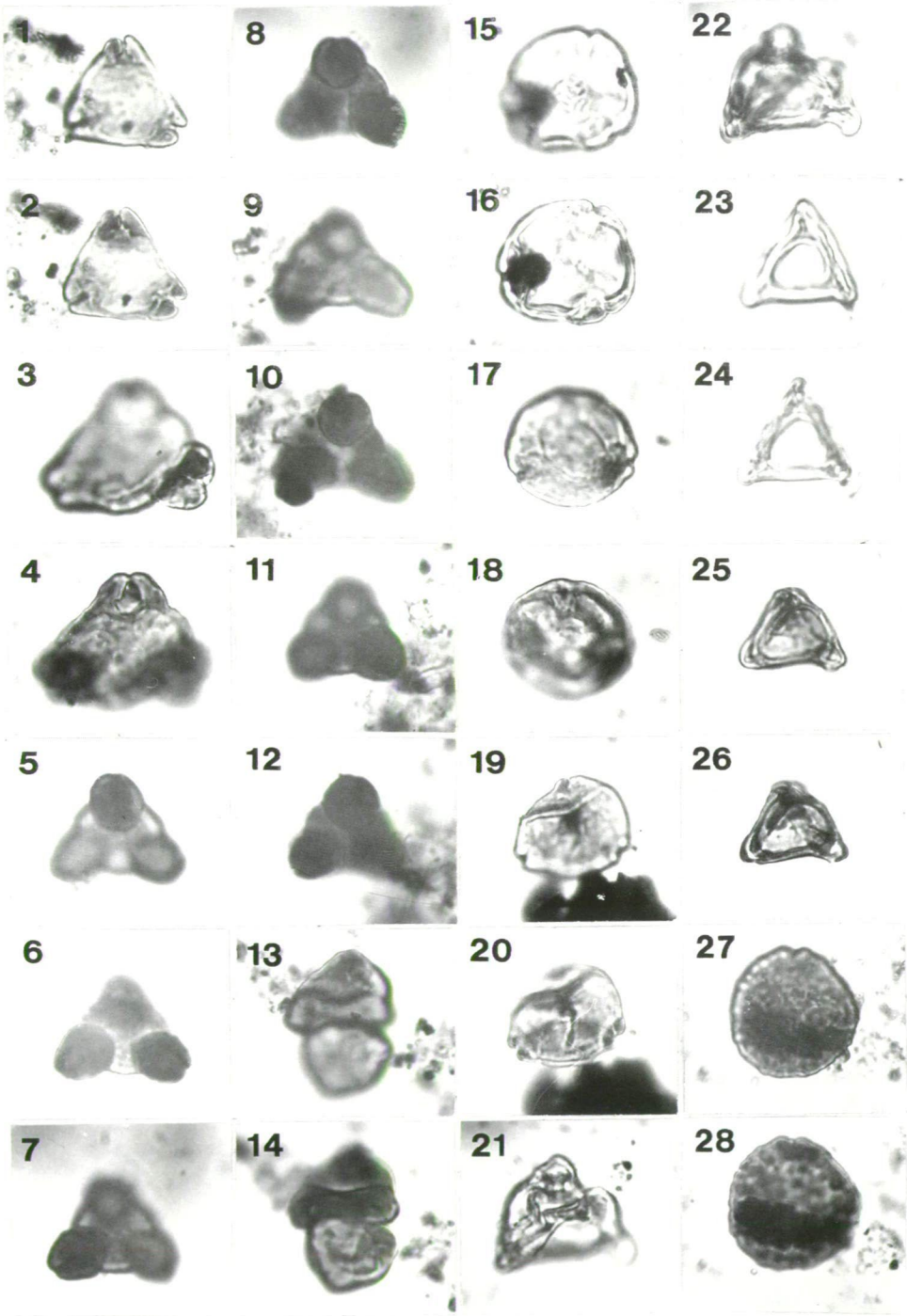

Plate 2.5.

Discussion and Conclusions

The organic microfossil content of the samples investigated is not rich but the data presented herein may be useful for the further investigations. Regarding the details the following may be pointed out:

1. The samples investigated are of Senonian age.
2. Among the plant tissue remnants the *monocotyledonous* (*Gramineae* type) epidermis remnant is worth of mentioning.
3. Some spores of *Gleicheniaceae* spores isolated from the layers of Boly are mostly characteristics for the Middle and/or Lower Cretaceous sediments. A reworking may be presumed.
4. The samples of the Csávoly Marl Section are poor in sporomorphs in comparison to the spore pollen assemblage from the samples investigated from the bore-hole Csávoly I. previously (KEDVES, 1983, 1984), and this assemblage was denominated as "Upper Senonian, Csávoly type". Taking into consideration our newest data about the upper part of the Senonian the Maestrichtian age may be excluded at these Senonian sediments. To this see the papers on the type locality of the Maestrichtian and the Fish Clay assemblages for the K/T boundary.

Acknowledgements

This work was supported by Grant OTKA T/9 023208.

Plate 2.5.

1,2. *Semioculopollis daniensis* KEDVES 1979; slide: Bácsalmás-I, 0/17-1, cross-table number: 12.2/145.1.
3,4. *Semioculopollis croxtonae* KEDVES 1979; slide: Bácsalmás-I, 0/14-3, cross-table number: 16.1/139.9.
5,6. *Oculopollis minoris* KRUTZSCH 1973; slide: Bácsalmás-I, 0/17-2, cross-table number: 22.7/137.3.
7,8. *Oculopollis minoris* KRUTZSCH 1973; slide: Bácsalmás-I, 0/17-4, cross-table number: 24.4/136.8.
9,10. *Oculopollis minoris* KRUTZSCH 1973; slide: Bácsalmás-I, 0/17-4, cross-table number: 21.9/132.8.
11,12. *Oculopollis minoris* KRUTZSCH 1973; slide: Bácsalmás-I, 0/17-5, cross-table number: 16.9/142.2.
13,14. *Oculopollis minoris* KRUTZSCH 1973; slide: Bácsalmás-I, 0/17-5, cross-table number: 10.9/137.8.
15,16. *Papillopollis* cf. *cretacicus* KEDVES et PITTAU 1979; slide: Bácsalmás-I, 0/17-1, cross-table number: 10.2/129.2.
17,18. Cf. *Druggipollenites* fsp.; slide: Bácsalmás-I, 0/15-2, cross-table number: 14.9/128.1.
19,20. *Triatriopollenites minimus* (GLADKOVA 1965) KEDVES 1974, *Juglandaceae*, *Engelhardtia*; slide: Bácsalmás-I, 0/14-3, cross-table number: 14.9/141.6.
21,22. *Interporopollenites* cf. *initium* (PFLUG 1953a) PFLUG 1953b; slide: Bácsalmás-I, 0/17-1, cross-table number: 11.2/137.3.
23,24. *Interporopollenites triangulus* KEDVES et HEGEDÜS 1975; slide: Bácsalmás-I, 0/17-3, cross-table number: 11.4/130.3.
25,26. *Interporopollenites guineti* KEDVES et HEGEDÜS 1975; slide: Bácsalmás-I, 0/16-1, cross-table number: 24.1/138.3.
27,28. *Subtriporopollenites constans* PFLUG 1953 subfsp. *crassiexinus* KEDVES 1970, *?Juglandaceae*; slide: Bácsalmás-I, 0/15-1, cross-table number: 8.6/142.2.

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3. UPPER CRETACEOUS POLLEN GRAINS FROM EGYPT IV.

M. KEDVES

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

This paper deals with the taxa of the following form-genera isolated from the Senonian sediments of Egypt: *Retitricolporites* (VAN DER HAMMEN 1956) VAN DER HAMMEN et WIJMSTRA 1964 - end, *Retibrevitricolporites* LEGOUX 1978, *Ilexpollenites* THIERGART 1937 (in RAATZ 1937), *Verrutricolporites* VAN DER HAMMEN et WIJMSTRA 1964, *Gemmatricolporites* LEIDELMEYER 1966, *Granotricolporites* KEDVES 1978, *Punctatricolporites* n. fgen., *Psilatricolporites* VAN DER HAMMEN 1956 ex PIERCE 1961, *Cupuliferoipollenites* R. POTONIÉ 1960, *Fususpollenites* KEDVES 1978, *Cyrillaceaepollenites* (MÜRRIGER et PFLUG 1951) R. POTONIÉ 1960, *Striatricolporites* (VAN DER HAMMEN 1956) LEIDELMEYER 1966, *Nagyipollis* KEDVES 1962, *Tubistephanocolpites* SALAMI 1984 emend. SCHRANK 1994. New taxa described in this paper: *Retibrevitricolporites legouxae* n. fsp., *Ilexpollenites aegypticus* n. fsp., *I. farafraensis* n. fsp., *Granotricolporites potoniei* n. fsp., *G. kirchheimerii* n. fsp., *G. druggii* n. fsp., *G. stanleyi* n. fsp., *Punctatricolporites africanus* n. fgen. et fsp., *P. semipunctatus* n. fsp., *P. farafraensis* n. fsp., *Psilatricolporites magloirae* n. fsp., *P. aegypticus* n. fsp., *Nagyipollis farafraensis* n. fsp., *Tubistephanocolpites schrankii* n. fsp.

Key words: Palynology, fossil, *Angiospermatophyta*, Upper Cretaceous, Egypt.

9. *Retitricolporites* fsp.
(Plate 3.1., figs. 1,2)

Description: Amb circular, surface finely reticulate. The lumina of the reticulum are 0.2-0.3 µm, in diameter and the muri about 0.2 µm wide. The exine is 2-2.5 µm thick, the infratectum is thicker than the tectum and the foot layer; T/I/F = 1/2-2.5/1. Furrows asymmetrical, one is shorter than the two others, and do not reach the poles. There are characteristic cavernae around the furrows, which are 2-3 µm wide near the endoapertures, and about 1 µm wide at the end of the furrows. Endoaperture very narrow, relatively long transversal furrow, 0.3 x 3-3.5 µm.

Diameter: 20 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent, Kharga (1-39) common.

Form-genus: *Retibrevitricolporites* LEGOUX 1978

This form-genus was described on the basis of a palynological study of the Neogene sediments of Nigeria. Several SEM pictures of these pollen grains were also published.

1. *Retibrevitricolporites legouxae* n. fsp.
(Plate 3.1., figs. 3,4)

Diagnosis: Amb circular in polar view. Surface very finely reticulate, sometimes foveolate. The lumen of the reticulum is 0.15-0.25 µm, the muri width is about 0.2 µm. The exine is 0.8-1.3 µm thick, the tectum, infratectum, and the foot layer are equal; T/I/F = 1/1/1. Structure intrabaculate. Furrows are about 10 µm long, around them the cavernae are thin and about 2.5 µm wide. Endoapertures about 6 µm long, 1-1.5 µm wide transversal furrows.

Diameter: 18 µm; 16-20 µm.

Holotype: Plate 3.1., figs. 3,4, slide: Kharga-1-39-2, cross-table number: 14.5/107.5.

Locus typicus: Kharga, Maestrichtian, Nubia Sandstone.

Stratum typicum: clay.

Derivatio nominis: In honour of Dr. O. LEGOUX.

Differential diagnosis: *R. obodoensis* LEGOUX 1978 is triangular, convex in polar view, with a slightly prominent germinal area.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Kharga (1-39) infrequent, Kharga (1-28) infrequent, Maestrichtian, fm. indet.: Oweina (3) infrequent.

Form-genus: *Ilexpollenites* THIERGART 1937 (in RAATZ 1937)

Concerning the history of the genus *Ilex*, H. MARTIN (1977) wrote the following; p. 655: "The pollen of *Ilex* is very distinctive and fossil specimens can be related to it with certainity. There is an undescribed fossil species in the Turonian (earliest Upper Cretaceous) of south-eastern Australia, where *Ilex* predates the first appearance of *Nothofagus*. *Ilexpollenites* spp. are usually present from Maestrichtian (latest Upper Cretaceous) to late Miocene." LOBREAU-CALLEN (1975) pointed out, that the variation in size of the *Ilex* species is related to longitude, latitude, altitude and to the climate.

1. *Ilexpollenites margaritatus* (R. POTONIÉ 1934) RAATZ 1937 forma *medius* PFLUG et THOMSON 1953, *Aquifoliaceae, Ilex*
(Plate 3.1., figs. 5-8)

Description: Amb ellipsoidal. Ornamentation clavate, the elements are about 3 µm high, the diameter of the capituli is 1.5-2.5 µm. The foot layer is relatively thin. The furrows do not reach the poles. Around the pole there are cavernae which are 2 µm in width. The endoapertures are not clearly discernible because of the clavate sculpture.

Polar axis: 22 µm; 20-25 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Kharga (1-28) infrequent.

Remarks: *I. margaritatus* f. *medius* is a relatively very common pollen type of the Tertiary spore-pollen assemblages of the Northern Hemisphere.

2. *Ilexpollenites aegypticus* n. fsp.
(Plate 3.1., figs. 9,10)

Diagnosis: Amb ellipsoidal. Surface clavate. The maximal thickness of the exine is 2.5-3 µm. The capituli of the clavae are 1-1.8 µm, furrows are long, and reach the poles. They converge near the poles. The cavernae are 2-3 µm in width. Endopores circular, and 3-4 µm in diameter.

Polar axis: 31 µm; 26-32 µm.

Holotype: Plate 3.1., figs. 7,8, slide: Farafra-6-2-1-10, cross-table number: 15.5/112.6.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clay.

Derivatio nominis: From Egypt.

Differential diagnosis: *I. deliciosus* SAH 1967 is larger (40-48 µm) than our new species.

Botanical affinity: *Aquifoliaceae, Ilex.*

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent.

3. *Ilexpollenites farafraensis* n. fsp.
(Plate 3.1., figs. 11-14)

Diagnosis: Amb ellipsoidal or sexangular in polar view. Surface clavate. The exine is 1.5-2 µm thick, the capituli are 1-1.3 µm in size. The furrows generally do not reach the poles, the cavernae are 2.5-3 µm in width. Endopori circular, and generally 2-3 µm in diameter.

Polar axis or maximum size: 22 µm; 21-25 µm.

Holotype: Plate 3.1., figs. 13,14, slide: Farafra-6-2-1-10, cross-table number: 15.3/113.6.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: From Farafra.

Differential diagnosis: The capituli of *I. erdtmani* KEDVES 1978 are larger (0.5-1 µm) than those of *I. farafraensis* n. fsp.

Botanical affinity: *Aquifoliaceae, Ilex.*

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) common, Farafra (11) common.

Form-genus: *Verrutricolporites* VAN DER HAMMEN et WIJMSTRA 1964

Tricolporate pollen grains, sculpture verrucate.

1. *Verrutricolporites bignoti* (GRUAS-CAVAGNETTO 1979) n. comb.
(Plate 3.1., figs. 15-18)

Syn.: 1976 *Tricolporopollenites bignoti* GRUAS-CAVAGNETTO, p. 33, pl. 10, figs. 14,15.

Description: Amb ellipsoidal. Surface verrucate. The basal diameter of the sculptural elements is 2-2.5 µm, and they are 0.5-0.7 µm high. The exine is 0.7-0.9 µm thick, the infratectal layer is thicker than the tectum and the foot layer; T/I/F = 1/2/1. Structure intrabaculate. The furrows reach the poles, around them there are narrow (0.5 µm) cavernae. Tiny circular endopori, which are 1.5 µm in diameter.

Polar axis: 18 µm; 16-22 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent.

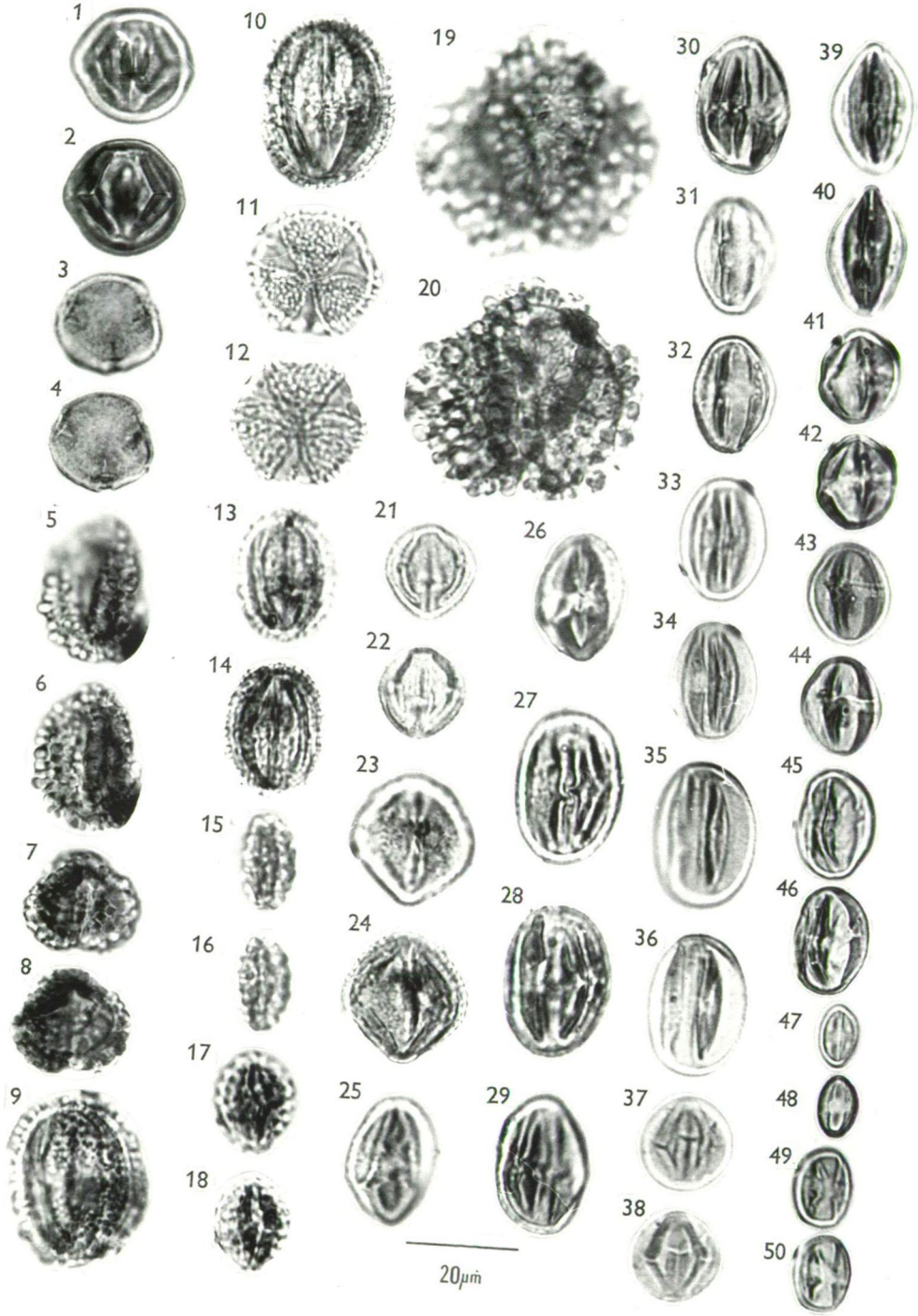
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Plate 3.1.

Form-genus: *Gemmatricolporites* LEIDELMEYER 1966

The gemmate sculpture is very characteristic of these tricolporate pollen grains. HUANG (1980) established the *Rutaceae* as the botanical affinity for his new species from the Miocene of Taiwan.

1. *Gemmatricolporites* fsp.
(Plate 3.1., figs. 19,20)

Description: Isodiametric pollen grains, with gemmate sculpture. The diameter of the sculptural elements is 1.5-3 µm. The exine is 2.5-3.5 µm thick, the infratectal layer is the thickest between the ectexine layers; T/I/F = 1/2-3/1. Structure intrabaculate. The furrows reach the poles, the cavernae are 2-3 µm in width. The endoapertures are not easily discernible because of the sculpture, but they appear to be elliptical.

Diameter: 42 µm.

Remarks: Similar to *G. divaricatus* LEIDELMEYER 1966 from the Lower Paleogene of Guiana, but the Egyptian specimen is larger.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent.

Plate 3.1.

1,2. *Retitricolporites* fsp., slide: Abu Minquar-4-3-6, cross-table number: 19.6/112.5.
3,4. *Retibrevitricolporites legouxae* n. fsp., slide: Kharga-1-39-2, cross-table number: 14.5/107.5.
5,6. *Ilexpollenites margaritatus* (R. POTONIÉ 1934) RAATZ 1937 forma *medius* PFLUG et THOMSON 1953, *Aquifoliaceae, Ilex*, slide: Kharga-1-28-1, cross-table number: 4.5/110.8.
7,8. *Ilexpollenites margaritatus* (R. POTONIÉ 1934) RAATZ 1937 forma *medius* PFLUG et THOMSON 1953, *Aquifoliaceae, Ilex*, slide: Kharga-1-35-5, cross-table number: 14.5/105.5.
9,10. *Ilexpollenites aegypticus* n. fsp., *Aquifoliaceae, Ilex*, slide: Farafra-6-2-1-10, cross-table number: 15.5/112.6.
11,12. *Ilexpollenites farafraensis* n. fsp., *Aquifoliaceae, Ilex*, slide: Farafra-6-2-2-4, cross-table number: 9.9/114.6.
13,14. *Ilexpollenites farafraensis* n. fsp., *Aquifoliaceae, Ilex*, slide: Farafra-6-2-1-10, cross-table number: 15.3/113.6.
15,16. *Verrutricolporites bignoti* (GRUAS-CAVAGNETTO 1970) n. comb., slide: Farafra-6-2-2-6, cross-table number: 9.4/105.8.
17,18. *Verrutricolporites bignoti* (GRUAS-CAVAGNETTO 1970) n. comb., slide: Farafra-6-2-1-3, cross-table number: 10.1/118.3.
19,20. *Gemmatricolporites* fsp., slide: Farafra-6-2-1-1, cross-table number: 19.1/115.8.
21,22. *Granotricolporites potoniei* n. fsp., slide: Farafra-6-2-2-4, cross-table number: 7.7/116.3.
23,24. *Granotricolporites kirchheimerii* n. fsp., slide: Abu Minquar-4-3-4, cross-table number: 7.3/108.4.
25,26. *Granotricolporites druggii* n. fsp., slide: Farafra-6-2-2-6, cross-table number: 17.1/101.4.
27,28. *Granotricolporites druggii* n. fsp., slide: Farafra-6-2-1-6, cross-table number: 14.4/106.3.
29,30. *Granotricolporites druggii* n. fsp., slide: Farafra-6-2-1-6, cross-table number: 7.6/109.6.
31,32. *Granotricolporites stanleyi* n. fsp., slide: Abu Minquar-4-3-8, cross-table number: 17.2/115.6.
33,34. *Punctatricolporites africanus* n. fsp., slide: Abu Minquar-4-3-6, cross-table number: 8.3/103.3.
35,36. *Punctatricolporites africanus* n. fsp., slide: Farafra-6-2-2-10, cross-table number: 11.8/103.1.
37,38. *Punctatricolporites semipunctatus* n. fsp., slide: Farafra-6-2-2-7, cross-table number: 7.2/104.3.
39,40. *Punctatricolporites farafraensis* n. fsp., slide: Farafra-6-2-1-9, cross-table number: 9.4/111.8.
41,42. *Psilatricolporites magloirae* n. fsp., slide: Farafra-6-2-1-10, cross-table number: 4.9/114.3.
43,44. *Psilatricolporites magloirae* n. fsp., slide: Abu Minquar-4-3-10, cross-table number: 20.2/106.6.
45,46. *Psilatricolporites aegypticus* n.fsp., slide: Abu Minquar-4-3-5, cross-table number: 19.6/106.4.
47,48. *Cupuliferoipollenites insleyanus* (TRAVERSE 1955) R. POTONIÉ 1960, *Fagaceae* cf. *Castanea*, slide: Kharga-1-39-3, cross-table number: 12.7/110.3.
49,50. *Cupuliferoipollenites* cf. *oviformis* (R. POTONIÉ 1931a) R. POTONIÉ 1960, *Fagaceae*, cf. *Castanea*, slide: Farafra-6-2-1-2, cross-table number: 17.8/98.8.

Form-genus: *Granotricolporites* KEDVES 1978
These pollen grains are tricolporate, with a granulate surface.

1. *Granotricolporites potoniei* n. fsp.
(Plate 3.1., figs. 21,22)

Diagnosis: Amb circular or elliptical. Surface finely granulate, the size of the sculptural elements is about 0.2 µm. The exine is 0.7-0.9 µm thick. The tectum, infratectal layer, and the foot layer are of equal thickness. The furrows are asymmetrical and they converge in the polar direction. The caverna is 0.7-0.9 µm wide. Around the furrows there are short plicae (pseudo-furrows). The endoapertures are meridionally elongated short colpi (rugae), 0.5 x 3-3.5 µm.

Polar axis: 17 µm; 15-20 µm.

Holotype: Plate 3.1., figs. 21,22, slide: Farafra-6-2-2-4, cross-table number: 7.7/116.3.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: In memoriam of Prof. Dr. R. POTONIÉ pioneer of the Pre-Quaternary Palynology.

Differential diagnosis: The smaller size, the thicker exine and in particular the endoaperture separates this taxon from *G. semiglobosus* (KEDVES 1963) KEDVES 1978.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (11) infrequent.

2. *Granotricolporites kirchheimerii* n. fsp.
(Plate 3.1., figs. 23,24)

Diagnosis: Generally isodiametric or ellipsoidal pollen grains. Surface granulate-reticulate, the size of the ornamental elements is 0.3 µm. The exine is 2-2.5 µm thick. The tectum, infratectum and the foot layer are of equal thickness; T/I/F = 1/1/1. The furrows do not reach the poles but they converge in the polar direction. The caverna is 1.8-2.5 µm thick. Endoapertures circular, and 2-3 µm in diameter.

Polar axis: 23 µm; 19-28 µm.

Holotype: Plate 3.1., figs. 23,24, slide: Abu Minquar-4-3-4, cross-table number: 7.3/108.4.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Prof. Dr. F. KIRCHHEIMER pioneer of the Pre-Quaternary Palynology of Africa.

Differential diagnosis: The larger size and the not so typical surface ornamentation separates this species from *G. potoniei* n. fsp.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent.

3. *Granotricolporites druggii* n. fsp.
(Plate 3.1., figs. 25-30)

Diagnosis: Amb ellipsoidal. Surface granulate, but the tectum is sometimes perforated. The exine is 1.5-2.2 µm thick, the foot layer is relatively thick; T/I/F = 1/1/3-5.

Structure finely intrabaculate. The furrows are long, but in general do not reach the poles. The caverna is 2-2.8 μm thick. The endoapertures are usually 5 μm in diameter.

Polar axis: 28 μm; 25-30 μm.

Holotype: Plate 3.1., figs. 27,28, slide: Farafra-6-2-1-6, cross-table number: 14.4/106.3.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clay.

Derivatio nominis: In memoriam of Dr. W.S. DRUGG excellent investigator of the Pre-Quaternary sporomorphs.

Differential diagnosis: The very tiny sculptural elements, and the ellipsoidal ambitus separates this taxon from the previously described species.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent.

4. *Granotricolporites stanleyi* n. fsp.
(Plate 3.1., figs. 31,32)

Diagnosis: Amb ellipsoidal, surface finely granulate. Sometimes the ornamental elements anastomose. The exine is 0.7-1.3 μm thick. The tectum, infratectum and the foot layer are of equal thickness. Structure is not clearly discernible by optical microscopy but is probably granular. The furrows are long, but do not always reach the poles. The cavernae are 1-1.6 μm wide. Endopore circular and 2.5-3 μm in diameter.

Polar axis: 21 μm; 17-25 μm.

Holotype: Plate 3.1., figs. 31,32, slide: Abu Minquar-4-3-8, cross-table number: 17.2/115.6.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. E.A. STANLEY, excellent investigator of the Upper Cretaceous and Tertiary sporomorphs.

Differential diagnosis: The narrower caverna separates this taxon from *G. druggii* n. fsp.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) common.

Form-genus: *Punctatricolporites* n. fgen.

Form-genus type: *Punctatricolporites africanus* n. fgen. et fsp.
(Plate 3.1., figs. 33-36)

Diagnosis: Tricolporate pollen grains, surface punctate. Around the colpi there are cavernae.

Form-genus type: Plate 3.1., figs. 33,34, slide: Abu Minquar-4-3-6, cross-table number: 8.3/103.3.

Stratum typicum: coaly clay.

Derivatio nominis: From the most important morphological characteristic features.

Differential diagnosis: The punctate surface separates this taxon from the psilate or scabrate tricolporate pollen grains. *Magnopollis* KONZALOVÁ 1976 has a smooth or finely punctate surface. Moreover the pollen grains of KONZALOVÁ's (1976) genus are larger than those of our new form-genus.

1. *Punctatricolporites africanus* n. fsp.
(Plate 3.1., figs. 33-36)

Diagnosis: Amb ellipsoidal. Surface finely punctate. The exine is 1.2-1.6 μm thick. The tectum, infratectal layer and the foot layer are of equal thickness; T/I/F = 1/1/1. The structure is not clearly discernible by optical microscopy but is probably granular. The furrows are long, but in general do not reach the poles. The cavernae are 2-3 μm wide in the endoaperture region and become narrower in the polar direction. Endoapertures circular, 3-4 μm in diameter.

Polar axis: 22 μm; 20-26 μm.

Holotype, locus typicus, stratum typicum see previously.

Derivatio nominis: From Africa.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Abu Minquar (4-3).

2. *Punctatricolporites semipunctatus* n. fsp.
(Plate 3.1., figs. 37,38)

Diagnosis: Amb generally circular. Surface finely punctate but sometimes very finely reticulate. The exine is 0.6-0.8 μm thick. The infratectal layer is a little thicker than the tectum and the foot layer; T/I/F = 1/1.5-2/1. Structure finely intrabaculate. The furrows are long, but do not always reach the poles. They converge in the polar direction. The caverna is 1.8-2.3 μm wide. The endoapertures are 3-4 μm long. They consists of meridionally oriented furrows about 0.4 μm wide.

Diameter: 18 μm; 14-20 μm.

Holotype: Plate 3.1., figs. 37,38, slide: Farafra-6-2-2-7, cross-table number: 7.2/104.3.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: From its peculiar sculpture.

Differential diagnosis: The smaller size, and the contour separates this species from *P. africanus* n. fsp.

Remarks: There are intermediate forms to *Retitricolporites aegypticus* KEDVES 1999, so it seems, that in this case, the sculpture type is not a particularly distinctive characteristic feature.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent.

3. *Punctatricolporites farafraensis* n. fsp.
(Plate 3.1., figs. 39,40)

Diagnosis: Amb ellipsoidal. Surface finely punctate. The exine is 0.8-1.4 μm thick. The infratectum is thicker than the tectum and the foot layer; T/I/F = 1/1.5-2/1. Structure intrabaculate. The furrows converge in the polar direction and usually reach the poles. The caverna is 1.5-2.5 μm in width. Endoapertures circular, and about 4 μm in diameter.

Polar axis: 24 μm; 19-26 μm.

Holotype: Plate 3.1., figs. 39,40, slide: Farafra-6-2-1-9; cross-table number: 9.4/111.8.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clay.
Derivatio nominis: From Farafra.
Differential diagnosis: The larger furrows, which converge in the polar area, and the narrower amb separates this taxon from *P. africanus* n. fsp.
Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent.

Form-genus: *Psilatricolporites* VAN DER HAMMEN 1956 ex PIERCE 1961
Psilate, tricolporate pollen grains.

1. *Psilatricolporites magloirae* n. fsp.
(Plate 3.1., figs. 41-44)

Syn.: 1965 *Tricolporopollenites* sp. JARDINÉ and MAGLOIRE, p. 216, pl. 11, figs. 11-15.

Diagnosis: Amb circular to ellipsoidal, surface smooth. The exine is 1-1.3 µm thick. The infratectum is a little thicker, than the tectum and the foot layer; T/I/F = 1/1.5/1. Structure not clearly discernible by optical microscopy, probably finely intrabaculate. The furrows reach the poles, and converge in this direction. The caverna is 1-1.3 µm in width. The endoapertures are meridionally oriented short furrows, 0.8-1.2 µm wide and about 5 µm long.
Diameter: 17 µm; 16-19 µm.
Holotype: Plate 3.1., figs. 41,42, slide: Farafra-6-2-1-10, cross-table number: 4.9/114.3.
Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.
Stratum typicum: clay.
Derivatio nominis: In honour of Dr. L. MAGLOIRE excellent investigator of the Cretaceous sporomorphs of Africa.
Differential diagnosis: *T. debilis* GROOT, PENNY et GROOT 1961 is 16 x 13 µm in size, and has a psilate or faintly scabrate surface.
Remarks: Based on the documents of JARDINÉ et MAGLOIRE (1965, p. 216, pl. 11, figs. 11-15) this species occurs in the Turonian - Lower Senonian layers of Senegal, and in the Lower Senonian of the Ivory Coast.
Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Farafra (11) common, Abu Minquar (4-3) infrequent.

2. *Psilatricolporites aegypticus* n. fsp.
(Plate 3.1., figs. 45,46)

Diagnosis: Amb ellipsoidal, surface smooth. Exine is 0.6-0.8 µm thick. The tectum, infratectum and the foot layer are equal; T/I/F = 1/1/1. Structure is not clearly discernible by optical microscopy, probably finely granular. The furrows are long, but do not always reach the poles. The cavernae are 1.5 µm in width. The endoapertures consists of circular pori about 2 µm in diameter.
Polar axis: 18 µm; 16-20 µm.
Holotype: Plate 3.1., figs. 45,46, slide: Abu Minquar-4-3-5, cross-table number: 19.6/106.4.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.
Stratum typicum: coaly clay.
Derivatio nominis: From Egypt.
Differential diagnosis: The larger furrows, and the narrower cavernae separates this species from *P. gregussii* KEDVES 1978.
Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Abu Minquar (4-3) infrequent.

Form-genus: *Cupuliferoipollenites* R. POTONIÉ 1960
This form-genus circumscribes one group of psilate tricolporate pollen grains, the so-called "*Castaneoidae* types". SEM data from *C. cingulum* by POTTER (1976).

1. *Cupuliferoipollenites insleyanus* (TRAVERSE 1955) R. POTONIÉ 1960, *Fagaceae*, cf. *Castanea*
(Plate 3.1., figs. 47,48)

Description: Amb ellipsoidal, surface psilate. The exine is 0.6-0.8 µm thick and the three layers of the ectexine are of equal thickness; T/I/F = 1/1/1. Structure not clearly discernible by optical microscopy. The furrows reach the poles and the cavernae are 0.2-0.3 µm wide. Endopore circular, 1.5-2.5 µm in diameter.
Polar axis: 12 µm; 9-13 µm.
Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) common, Kharga (1-39) common.

2. *Cupuliferoipollenites* cf. *oviformis* (R. POTONIÉ 1931a) R. POTONIÉ 1960, *Fagaceae*, cf. *Castanea*
(Plate 3.1., figs. 49,50)

Description: Amb ellipsoidal, surface smooth. The exine is 1.2-1.4 µm thick. The tectum, infratectum and the foot layer are of equal thickness. The furrows do not always reach the poles. The cavernae near the endoapertures are about 2 µm wide and become narrower in the direction of the poles. Endoaperture, in general circular and about 3 µm in diameter.
Polar axis: 13 µm; 12-16 µm.
Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone (6-2-1) infrequent, Farafra (11) infrequent, Kharga (1-39) frequent, Kharga (1-28) infrequent.

3. *Cupuliferoipollenites pusillus* (R. POTONIÉ 1934) R. POTONIÉ 1960, *Fagaceae* cf. *Castanea*
(Plate 3.2., figs. 1,2)

Description: Amb ellipsoidal, surface smooth or finely scabrate. The exine is 0.8-1.2 µm thick. The tectum, infratectum and the foot layer are equal. The structure is not discernible by optical microscopy. The furrows generally reach the equator, the cavernae are 1.2-1.5 µm wide. The endopores are in general meridionally oriented ellipsoidal apertures, 3-3.5 µm in size.
Polar axis: 19 µm; 17-22 µm.

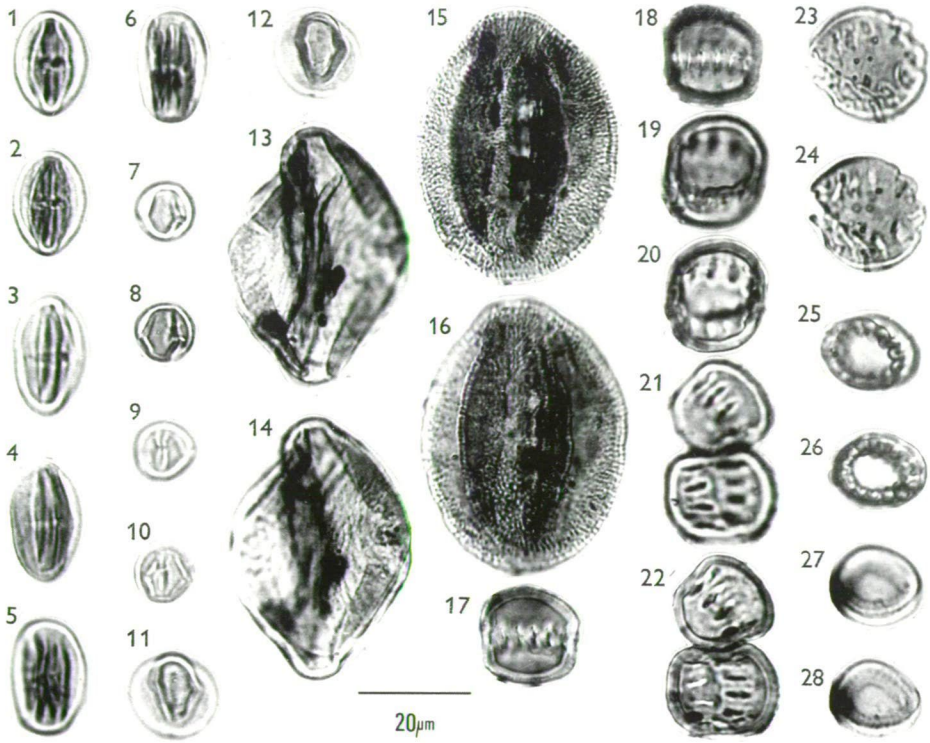

Plate 3.2.

1,2. *Cupuliferoipollenites pusillus* (R. POTONIÉ 1934) R. POTONIÉ 1960, *Fagaceae*, cf. *Castanea*, slide: Abu Minquar-4-3-3, cross-table number: 14.8/102.9.
3,4. *Fususpollenites fusus* (R. POTONIÉ 1934) KEDVES 1978, *Fagaceae, Castanopsis*, slide: Farafra-6-2-1-2, cross-table number: 13.5/114.6.
5,6. *Fususpollenites fusus* (R. POTONIÉ 1934) KEDVES 1978, *Fagaceae, Castanopsis*, slide: Abu Minquar-4-3-3, cross-table number: 10.5/117.4.
7,8. *Cyrillaceaepollenites exactus* (R. POTONIÉ 1931b) R. POTONIÉ 1960, *Cyrillaceae, Clethraceae* v. *Theaceae*, slide: Farafra-6-2-2-1, cross-table number: 4.6/109.6.
9.10. *Cyrillaceaepollenites exactus* (R. POTONIÉ 1931b) R. POTONIÉ 1960, *Cyrillaceae, Clethraceae* v. *Theaceae*, slide: Farafra-6-2-2-5, cross-table number: 11.1/111.8.
11,12. *Cyrillaceaepollenites megaexactus* (R. POTONIÉ 1931b) R. POTONIÉ 1960, *Cyrillaceae, Clethraceae* v. *Theaceae*, slide: Farafra-6-2-2-2. cross-table number: 18.7/100.6.
13,14. Cf. *Striatricolporites* fsp., slide: Kharga-1-28-1, cross-table number: 9.8/111.6.
15,16. *Nagyipollenites farafraensis* n. fsp., slide: Farafra-6-2-1-6, cross-table number: 17.3/112.6.
17,18. *Tubistephanocolpites schrankii* n. fsp., slide: Farafra-6-2-1-6, cross-table number: 104/106.8.
19,20. *Tubistephanocolpites schrankii* n. fsp., slide: Farafra-6-2-1-7, cross-table number: 10.1/112.6.
21,22. *Tubistephanocolpites schrankii* n. fsp., slide: Farafra-6-2-1-11, cross-table number: 6.3/110.7.
23,24. *Tubistephanocolpites cylindricus* SALAMI 1984, slide: Farafra-6-2-1-6, cross-table number: 4.1/102.8.
25,26. *Tubistephanocolpites* fsp., slide: Farafra-6-2-1-4, cross-table number: 4.2/109.5.
27,28. Cf. *Tubistephanocolpites* fsp., slide: Farafra-11-1, cross-table number: 12.2/103.2.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) common, Farafra (11) infrequent, Duwi Range (100) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent, Kharga (1-28) frequent; Maestrichtian, fm. indet.: Oweina (3) common.

Form-genus: *Fususpollenites* KEDVES 1978
Tricolporate pollen grains, surface smooth, the structure is intrarugulate.

1. *Fususpollenites fusus* (R. POTONIÉ 1934) KEDVES 1978, *Fagaceae, Castanopsis*
(Plate 3.2., figs. 3-6)

Description: Amb ellipsoidal. Surface smooth to scabrate. The exine is 1.2-1.5 μm thick, the infratectum is a little thicker than the tectum and the foot layer; T/I/F = 1/1.5/1. Structure intrabaculate, or intrarugulate. The furrows reach the poles, and the cavernae are 1.5-2 μm in width. The endoapertures are meridionally oriented, ellipsoidal pores or short furrows: 3-4 x 2 μm.
Polar axis: 21 μm; 18-25 μm.
Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent.

Form-genus: *Cyrillaceaepollenites* (MÜRRIGER et PFLUG 1951) R. POTONIÉ 1960
Psilate, tricolporate pollen grains, more or less spherical. The colpi are of the characteristic *Cyrillaceae, Clethraceae* or *Theaceae* (*Eurya*, etc.) type.

1. *Cyrillaceaepollenites exactus* (R. POTONIÉ 1931b) R. POTONIÉ 1960, *Cyrillaceae, Clethraceae* v. *Theaceae*
(Plate 3.2., figs. 7-10)

Description: Amb circular to ellipsoidal. Surface smooth. The exine is 0.8-1.2 μm thick. The tectum, infratectum, and the foot layer are of equal thickness. The furrows converge in the direction of the poles and usually reach the apices. The cavernae are 0.6-0.8 μm in width. The endoapertures are meridionally oriented short colpi, about 2 μm long, and 0.5 μm wide.
Diameter: 10 μm; 8-12 μm.
Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) dominant, Farafra (6-2-1) dominant, Farafra (11) dominant, Abu Minquar (4-3) dominant, Kharga (1-39) common, Kharga (1-28) common.

2. *Cyrillaceaepollenites megaexactus* (R. POTONIÉ 1931b) R. POTONIÉ 1960, *Cyrillaceae, Clethraceae* v. *Theaceae*
(Plate 3.2., figs. 11,12)

Description: Amb circular to ellipsoidal. Surface smooth to scabrate. The exine is 0.6-0.8 μm thick. The infratectum is a little thicker than the tectum and the foot layer. Structure finely intragranulate. The furrows generally reach, and fuse at the poles, and diverge in the endoapertural region to the ambitus. The cavernae are 1-1.2 μm wide, the endoapertures are short colpi, 0.4 x 3 μm in size.

Diameter: 15 µm; 13-17 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) common, Farafra (11) frequent, Abu Minquar (4-3) frequent, Kharga (1-39) frequent, Kharga (1-28) frequent.

Form-genus: *Striatricolporites* (VAN DER HAMMEN 1956) LEIDELMEYER 1966

Striate, tricolporate pollen grains.

1. Cf. *Striatricolporites* fsp.
(Plate 3.2., figs. 13,14)

Description: Four lobed, tricolporate-tricolporoidate pollen grains. Surface striate and perforate. The exine is 0.8-1 µm thick on the sides, and 1.5-2 µm on the apices. The infratectal layer is a little, thicker than the tectum and the foot layer; T/I/F = 1/1.5/1. Because we have observed only one poorly preserved specimen, the condition of the apertural area was not suitable for exact morphological investigations.

Polar axis: 47 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Kharga (1-28) infrequent.

Form-genus: *Nagyipollis* KEDVES 1962

Most important characteristic features of these pollen grains. The number of the colpi are three, and there are two or more endopori on one colpus.

1. *Nagyipollis farafraensis* n. fsp.
(Plate 3.2., figs. 15,16)

Diagnosis: Amb ellipsoidal, surface reticulate, the lumina of the reticulum are 0.6-1 µm. The exine is 1.5-2 µm thick. The infratectal layer is thickest between the exine layers; T/I/F = 1/2/1. The furrows in general do not reach the poles. The caverna is 2-3 µm wide. There are usually three endopori per furrow, circular and about 3 µm in diameter.

Polar axis: 47 µm; 43-50 µm.

Holotype: Plate 3.2., figs. 15,16, slide: Farafra-6-2-1; cross-table number: 17.3/112.6.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: aleurite.

Derivatio nominis: From Farafra.

Differential diagnosis: The relatively great size distinguishes this species from *N. globus* KEDVES 1962.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent.

SUBTURMA: *PTYCHOPOLYPORINES* (*PTYCHOPOLYPORINA* NAUMOVA 1937, 1939) R. POTONIÉ 1960b

Form-genus: *Tubistephanocolpites* SALAMI 1984 emend. SCHRANK 1994

Polycolporate (12-15-20) pollen grains. The colpi are short and are usually about 1/4 or 1/3 the length of the polar axis, there are characteristic meridional "*cingulum*-like" thickening around the margin of the zone of the germinal apertures.

1. *Tubistephanocolpites schrankii* n. fsp.
(Plate 3.2., figs. 17-22)

Diagnosis: Polycolporate pollen grains, with cylindrical form, or ellipsoidal ambitus. Surface smooth or finely scabrate. The exine is 1.8-2.2 µm thick. Under the ectexine there is another separate layer, probably the endexine. The different ectexine layers, and the endexine are of equal thickness; T/I/F = 1/1/1. The fine structure of the infratectal layer is not discernible by optical microscopy but is probably granular. The number of the apertures is generally 12. The exoapertures are 4-5 µm long, and 0.5-0.8 µm wide. The endoapertures are 2.5-3 x 1.5 µm in size. The internal thickening at the margin of the apertural, zone is 1-1.2 µm wide, and 0.8-1.2 µm thick.

Polar axis: 17 µm; 16-20 µm.

Holotype: Plate 3.2., figs. 17,18, slide: Farafra-6-2-1-6, cross-table number: 10.4/106.8.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clay.

Derivatio nominis: From Dr. E. SCHRANK, excellent investigator of the Cretaceous palynomorphs of Sudan and Egypt.

Differential diagnosis: The thicker exine and the smaller size distinguishes this form-species from *T. cylindricus* SALAMI 1984.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Farafra (11) infrequent.

2. *Tubistephanocolpites cylindricus* SALAMI 1984
(Plate 3.2., figs. 23,24).

Description: One poorly preserved specimen occurred in our material which may be identical with the species from Senegal. Surface smooth or scabrate. The exine is 0.6-1 µm thick, endexine is not present based on the light microscope investigations. Tectum, infratectal layer and the foot layer are of equal thickness; T/I/F = 1/1/1. Structure finely intrabaculate. The number of the apertures is 12. The exoapertures are 4-6 µm wide. The size of the endoapertures is usually 2 µm. The germinal thickening is not characteristic. It is narrow and usually about 1 µm wide.

Maximum size: 20 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent.

3. *Tubistephanocolpites* fsp.
(Plate 3.2., figs. 25,26)

Description: Several specimens of this pollen type occurred in our material, they were usually in a polar position so they are probably isodiametric. Surface scabrate or punctate. The exine is 1-1.3 µm thick, and composed only of ectexine. The three ectexine layers are of equal thickness; T/I/F = 1/1/1. The number of apertures is 12-14. They exhibit very characteristic internal thickenings around the apertural zone and the width of this thickened part is about 1 µm. The fine morphology of the apertures was not observed in our specimens because of the preferred orientation of the pollen grains.

Diameter: 12.5 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent.

4. Cf. *Tubistephanocolpites* fsp.
(Plate 3.2., figs. 27,28)

Description: Only one poorly preserved specimen was found of this interesting pollen type. Surface punctate, the exine is 0.8-1.2 μm thick. The tectum, infratectal layer and the foot layer are of equal thickness; T/I/F = 1/1/1. The number of the apertures is 26, but the detailed morphology was not discernible in our specimen, there is however, a very characteristic apertural thickening.

Diameter: 16 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (11) infrequent.

Remark. – The slides are deposited in the Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, Szeged, Hungary.

To be continued

Acknowledgements

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4. A PRELIMINARY PALYNOLOGICAL STUDY OF EPICLASTIC DEPOSITS FROM "CALDERA DE TABURIENTE". LA PALMA ISLAND, CANARY ARCHIPELAGO, SPAIN
ESTUDIO PALINOLOGICO PRELIMINAR DE DEPÓSITOS EPICLASTICOS PROCEDENTES DE LA CALDERA DE TABURIENTE. ISLA DE LA PALMA, CANARIAS

C. ALVAREZ RAMIS[1], N. LAAMARTI[1], and J. VEGAS[2]

1. Facultad de Geológicas U.C.M. 28040, Madrid, Spain, Paleobotánica y Palinologia, Dpt°/ U.E.I. de Paleontologia, 2. Dpt°/U.E.I. de Petrologia. UCM/CSIC.

Abstract

This progress report of preliminary palynological study of a clay level from vulcanological succession of central crater "La Palma Island". Fossil plant remains are not frequent in vulcanological series, but in Upper Neogene of "Caldera de Taburiente" we are found several forms of mega- and microflora. This paper refers only palynological data.

Palabras clave: Palinología, Neógeno, La Palma, Canarias.
Key words: Palynology, Neogene, La Palma Island, Canary Island.

Situatción y características geológicas

La Palma es una de las islas que integran el Archipelago Canario, que se sitúa en el Océano Atlántico, al Noroeste de Africa.

Esta isla adopta forma triangular, redondeada en su parte norte, estrechándose rápidamente hacia el sur. En el centro de su mitad septentrional se sitúa un amplio cráter denominado "Caldera de Taburiente", cuyo borde externo forma las cimas más elevadas de la isla, que alcanza los 2.483 m en el Roque de los Muchachos.

La parte norte de la isla la ocupan las escarpadas pendientes externas del cráter cortadas por profundos valles que terminan en la costa formado elevados acantilados. La parte meridional de la isla muestra, en toda su longitud en posición central, una estrecha cadena montañosa denominada "Cumbre Vieja" que a diferencia de la parte norte de la isla, carece de valles profundos (Mapa topográfico 1965). En varias zonas situadas en el sur de la Palma se conocen erupciones volcánicas recientes. La última actividad fue la del volcán "Tenequia" en Fuencaliente (1971).

Las muestras objeto de análisis palinológico fueron tomadas en el camino que desciende al cráter y que está señalado con una flecha en la figura 4.1.

En el interior de la caldera han aflorado sedimentos epiclásticos dispersos por las laderas, resultado de episodios erosivos, formando resaltes (denominados roques). Uno de éstos está formado por esmectitas y volcarenitas. El tipo facies predominante lo con-

stituyen capas de turbiditas, de limos y de arcillas masivas o con laminación paralela que contienen los restos de vegetales fósiles (Fig. 4.2). El ambiente sedimentario atribuido a su conjuncto es de tipo lacustre (VEGAS 1998 y VEGAS e.a. 1998).

Las muestras analizadas proceden de una capa de arcillas de unos 40 cm de espesor color ocre-amarillo. El medio sedimentario muestra laminación paralela formada por decantación y a techo hay un nivel de ripples de 5 cm de espesor. La potencia de la serie, en que se incluye el nivel estudiado es de 3 m de espesor total (Fig. 4.3). Estos sedimentos no están en su posición original, correspondiendo a tres bloques caídos, que no han sufrido gran transporte. Su caída parece ser consecuencia de la erosión de su base. Por encima se encuentran depósitos de piedemonte actuales, de unos 4 metros de potencia.

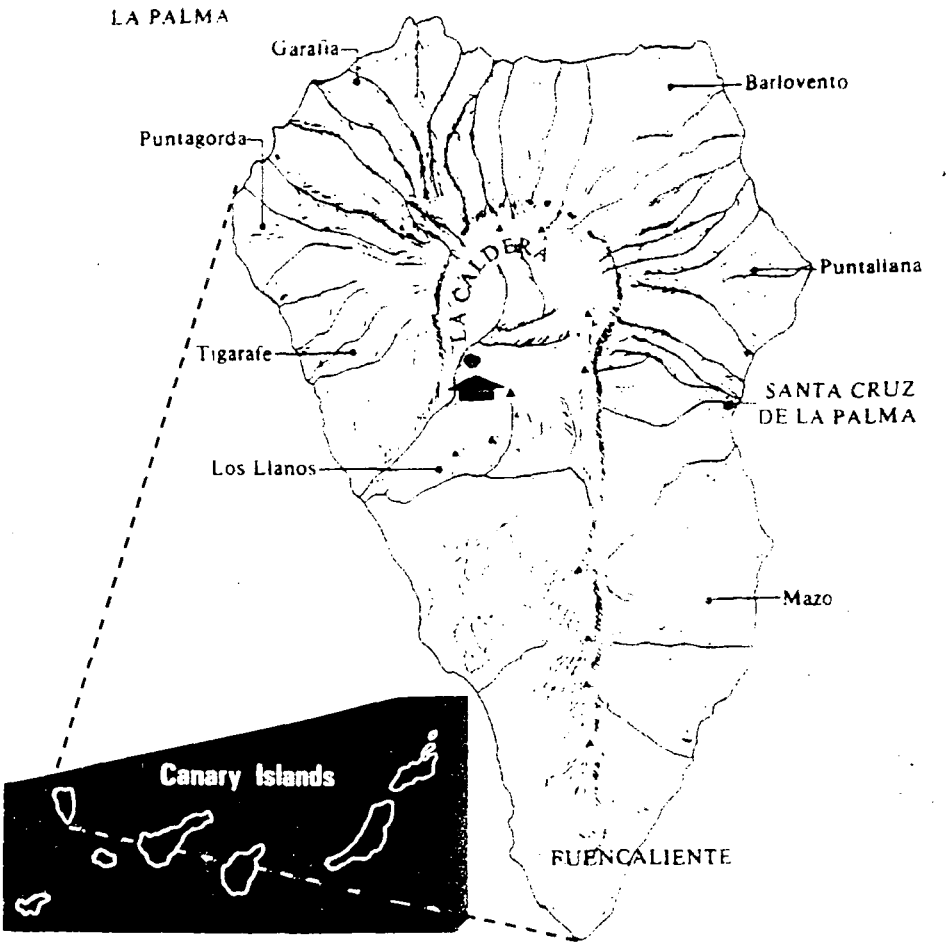

Fig. 4.1.

Isla de La Palma. Su situación en el archipielago Canario.

Metodológia

Las muestras de las que se obtuvieron los palinomorfos que se citan en esta nota, fueron tomadas por Juana VEGAS, preparadas por Nabila LAAMARTI y estudiadas por C. ALVAREZ RAMIS. El tratamiento seguido en la obtención y montaje de las muestras fue el que tradicionalmente se emplea en el laboratorio de Paleobotánica y Palinologia, ajustado a la naturaleza arcillosa de las muestras. Los minerales pesados que permanecían después de los tratamientos con FH, se eliminaron por un proceso de flotación con una solución de Br_2Zn al 1,95.

El montaje de los palinomorfos se hizo, según las técnicas usuales en muestras biológicas, en una mezcla al 50% de glicerina y agua, ya que por su baja densidad permite el giro y desplazamiento de los grana y de esta forma se pueden observar en distintas posiciones. Este tipo de montaje, por su movilidad, tiene el inconveniente, de no poder determinar, a posteriori, su situación precisa. El estudio y determinación de los distintos tipos de palinomorfos se efectuó en un microscopio óptico marca Nikon (Labophot-2), provisto de oculares de diez aumentos y objetivos de 20, 40 y 100 aumentos. Las fotografías que figuran en las láminas se tomaron con un equipo NIKON Microflex AFX-DX están aumentadas 1.000 veces.

Las determinaciones botánicas, climatológicas y estratigráficas se obtuvieron básicamente de BRAMWELL y BRAMWELL (1974), STUCHLIK (1964), STUCHLIK e.a. (1994) y VALDÉS e.a. (1987).

Palinomorfos determinados

-*Amaranthaceae-Chenopodiaceae*,
-*Araliaceae* fsp. (*Hedera* sp.?),
-*Botryococcus braunii* KÜTZ. *Cloroficea*,
-*Caryophyllaceae* fsp.,
-*Ceratophyllum* aff. *submersum* L.,
-Cupressaceae (Tipo *Juniperus* sp.),
-*Desmidiospora*. Primordio de *Microthyriacea*,
-*Ephedripites* fsp., *Ephedra* sp.?,
-*Gramineae* (Tipo *Dactylis*),
-*Graminidites bambusoides* STUCHLIK (Tipo *Bambusa*, *Oriza*, *Clidonia* o *Dendrocalamus*),
-*Juglandipollis juglandoides* KOLHMAN-ADAMSKA. *Juglans* sp.?,
-*Lycopodium* fsp.,
-*Magnolipollis neogenicus* KRUTZSCH. *Magnoliacea*,
-*Monocolpopollenites tranquillus* PF. y TH. *Palmae*,
-*Nyssapollenites* fsp.?,
-*Pinus* fsp. (Tipo *P. sylvestris* L.),
-*Pluricellasporites* fsp. *Phragmospora*,
-*Polyadosporites* fsp. Agrupación de esporas de *Ascomyceto*?,
-*Salicoidites* fsp. (*Salix* sp.),
-*Sparganiaceae-Typhaceae*,
-*Stereisporites* fsp. (*Sphagnum* sp.) *Muscinea*,
-*Tricolporopollenites* fsp. (Tipo *leguminosa*),
-*Trichopeltinites* fsp. Cuerpo fructífero de *Microthyriacea, Ascomiceto*.

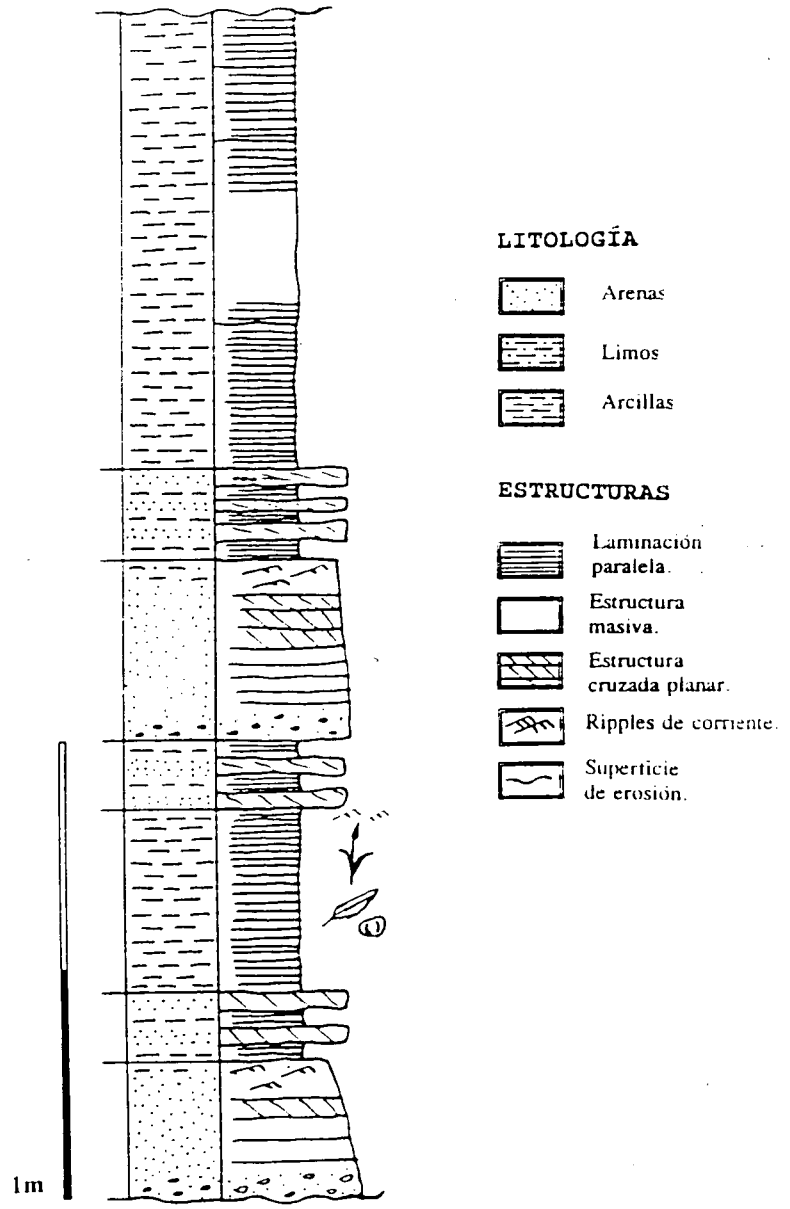

Fig. 4.2.

Serie local establecida en la Caldera de Taburiente que incluye la capa de arcillas analizada. Se indica la situación de los restos vegetales.

La densidad de palinomorfos en el nivel analizado es escasa y su obtención dificultosa, pues la mayoria de las esporodermis se desintegran con facilidad, si se exceptúan los hongos por la diferente composición de sus envueltas que es nitrogenada y no celulósica y sobre todo por sus caracteristicas vitales ya que muchos de ellos son saprofíticos o parasiticos y viven endo o epifitos.

Fig. 4.3.

Sedimentos laminados de color ocre-amarillo de 40 cm de espesor. Interior de la caldera de Taburiente. La Palma. Canarias.

Conclusiones

La paleoasociación formada por los fósiles vegetales estudiados (sauces, espadañas, licopodios, musgos, *Ceratophyllum, Botryococcus* etc.) confirma la existencia de un área lagunar en la que fosilizaron los vegetales como había sido supuesta anteriormente por VEGAS (1998) y VEGAS et al. (1998).

El paleoclima que puede atribuirse a la zona en la época de formación de la capa de arcillas analizada sería de cálido a templado.

La época de formación de la capa analizada puede corresponder al intervalo comprendido entre un Mioceno superior-Plioceno medio de acuerdo con la paleoasociación palinológica determinada. Si bien hay que tener en cuenta que se han estudiado poco más de un centenar de grana de los que solo hemos podio atribuir a grupos botánicos un 25%. Otros problemas añadidos son la insularidad y el discutido origen de la isla que pueden enmascarar la comparación con otras floras africanas y europeas sincrónicas.

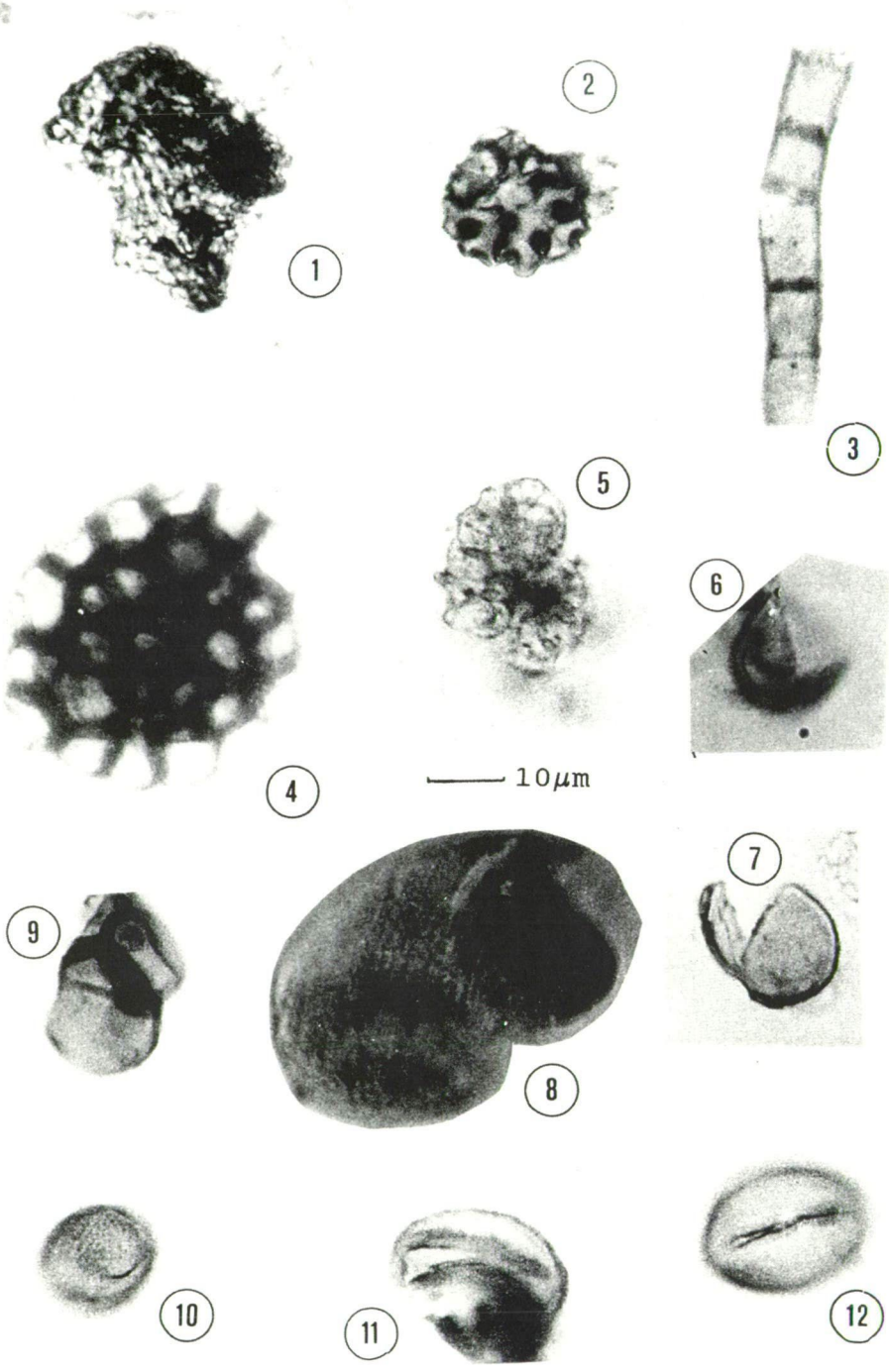

Lámina 4.1.

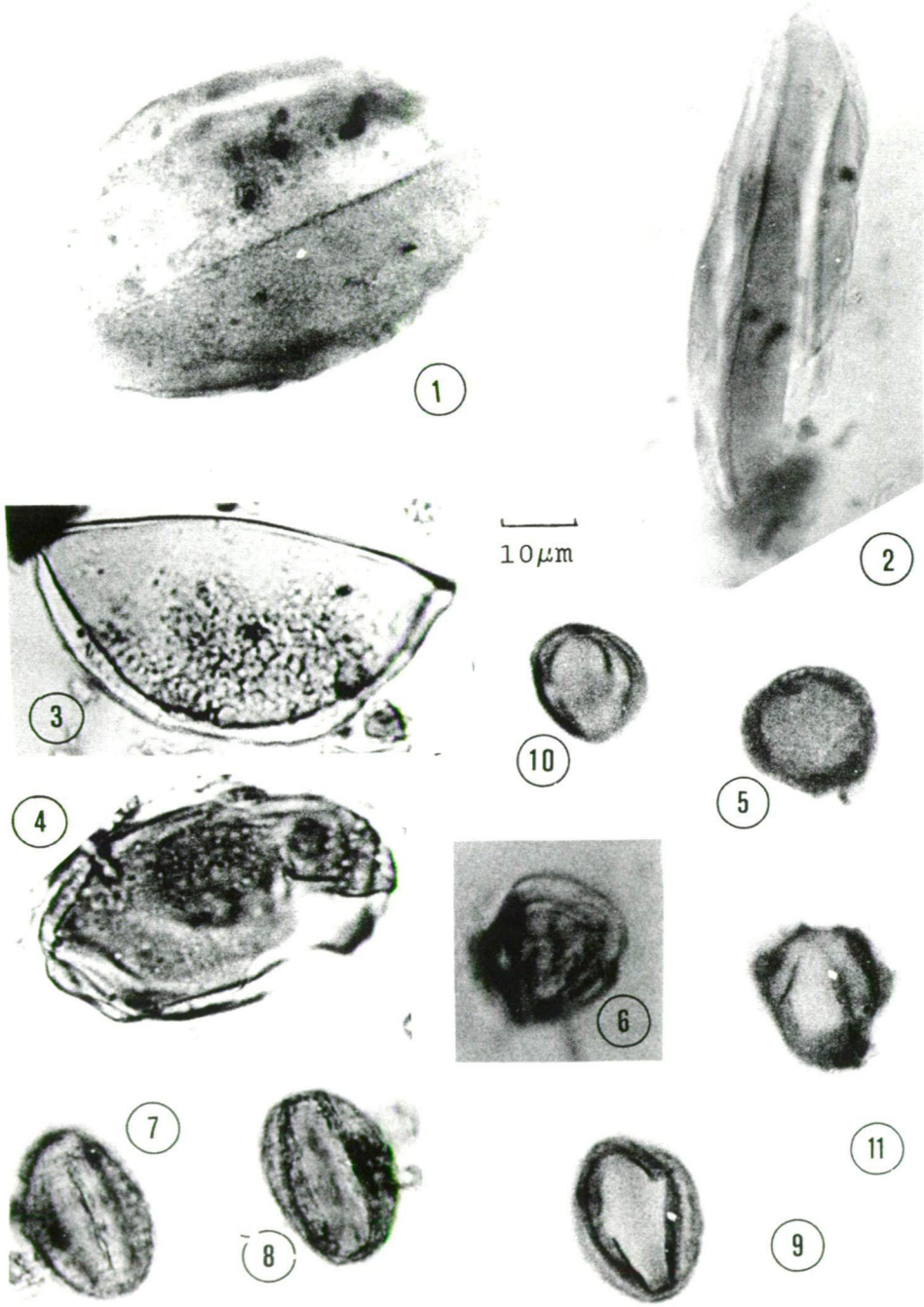

Lámina 4.2.

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Lámina 4.1.

1. *Trichopeltinites* sp.
2. *Desmidiospora* fsp.
3. *Pluricellasporites.*
4. *Polyadosporites* fsp.
5. *Botryococcus braunii* KÜTZ.
6-7. *Cupressaceae* (Tipo *Juniperus*).
8. *Pinaceae.*
9. *Gramineae* (Tipo *Dactylis*).
10. *Sparganiacea-Typhacea.*
11,12. *Monocolpopollenites tranquillus* (TH. & PF.) PF. & TH., *Palmae.*

Lámina 4.2.

1. *Graminidites bambusoides* STUCHLIK.
2. *Ephedripites* fsp., *Ephedra* sp.?
3. *Magnolipollis neogenicus* KRUTZSCH.
4. *Juglandipollis juglandoides* KOLHMAN-ADAMSKA.
5. *Periporopollenites* fsp. (*Caryophyllaceae*).
6. *Amaranthaceae-Chenopodiaceae.*
7-8. *Salicoidites* fsp. (*Salix* sp.).
9. *Araliaceoipollenites* fsp. (*Hedera* sp.?).
10. *Tricolporopollenites* fsp. (Tipo de *leguminosa*).
11. *Tricolporopollenites* aff. *kruschi* (*Nyssa* ?).

5. PALYNOLOGICAL INVESTIGATIONS ON HUNGARIAN NEOGENE LIGNITES

M. KEDVES

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

Palynological data and tissue fragments were investigated from Miocene and Upper Pannonian lignite samples from Hungary. The qualitative and quantitative results are presented in this contribution. Peculiar attention was paid to the reconstruction of the brown coal forming vegetation and for its zonation.

Key words: Palynology, fossil, Neogene, Hungary.

Introduction

There are a great number of publications of the spore-pollen assemblages of the Hungarian Neogene layers: Monographs on the Neogene sporomorphs in Hungary were published by E. NAGY (1958, 1969, 1985,1992a). Based on the geological ages and the character of the publications the following will be emphasized:

Miocene sporomorphs: MAÁCZ and SIMONCSICS (1956), SIMONCSICS (1959a,b, 1960, 1963, 1964, 1969), KEDVES (1959, 1960), E. NAGY (1962a, 1963b, 1968a, 1979a,b), BÓNA and RUMLI-SZENTAI (1966).

Organic planctonic microfossils: E. NAGY and BODOR (1982), FUCHS and SÜTŐ-SZENTAI (1991, 1994), JÁMBOR et al. (1985, 1987), JUHÁSZ et al. (1996).

Reconstruction of the zonation of the vegetation around the sedimentary basin: SIMONCSICS (1960), E. NAGY (1962b, 1976b). Paleofloristic and climatic changes, E. NAGY (1991, 1993), E. NAGY and Ó. KOVÁCS (1997). Description of the fossil mangrove from the Lower Badenian (E. NAGY and KÓKAY, 1990).

Pliocene sporomorphs: E. NAGY (1957b, 1959, 1988, 1989), E. NAGY and PLANDEROVÁ (1987), RÁKOSI (1963), MIHÁLTZ-FARAGÓ (1976), BODOR (1983).

Organic planctonic microfossils: E. NAGY (1976a), SÜTŐ-SZENTAI (1981, 1982a,b, 1983b,c, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994a, 1995a,b, 1999a,b in preparation).

Vegetation zonation in the Upper Pannonian: KEDVES (1962).

Neogene sporomorphs: E. NAGY (1963a,c,d, 1965c, 1968b, 1973).

Organic planctonic microfossils: E. NAGY (1965a,b, 1966), SÜTŐ-SZENTAI (1983a, 1994b, 1998).

Vegetation reconstruction: E. NAGY (1967, 1980).

Combined paleobotanical results from the Hungarian Neogene: E. NAGY and PÁLFALVY (1961), PÁLFALVY and RÁKOSI (1979).
Methodical papers: E. NAGY (1957a, 1961).

This contribution is within the combined investigations of the Hungarian Neogene lignites and included into the IGBP Global Change research program, B. Techniques for Extracting Environmental Data of the Past, 16. This paper presents in the first place the palynological results of the samples investigated previously geochemically by Prof. Dr. M. HETÉNYI.

Materials and Methods

Miocene
Bükkábrány mine: H/20-6, H/17-5, H/16-4, H/28-3. Horizontal sampling by 5 m.

Upper Pannonian: Torony Formation: Szombathely II, 189.5-189.7 m.
Tihany Formation: Szombathely II, 712.0-712.7 m.
Iharosberény sample No: 78, 130.1-130.3 m.
Tiszapalkonya bore-hole I: TK-I-10, 401.9-402.3 m, TK-I-19, 519.7-519.9 m, TK-I-8, 1217.8-1218.3 m.

The lignite samples were treated with HCl, HNO_3, KOH. The slides were mounted in glycerine jelly hydrated of 39.6%.
In the determination of the secondary xylem remnants monographs of GREGUSS (1945, 1955, 1967, 1969) were used. Concerning the organic planctonic remnant several monographies were investigated.

Results

Tissue fragments

Gymnosperm (Plate 5.1., figs. 1-4) and *angiosperm* (Plate 5.1., figs. 5,6) secondary woody fragments were observed in the macerated material. *Taxodiaceae-Cupressaceae, Taxaceae* or *Cephalotaxaceae, Abietaceae* may be presumed based on the xylotomical data. Fungal remnant within the tracheids (Plate 5.1., fig. 2) was also observed. The *angiosperm* vessel fragments refer to *Betulaceae* (*Alnus, Betula*) (Plate 5.1., fig. 5), and in all probability *Salicaceae* (Plate 5.1., fig. 6).

Palynological data
Taxonomy

Plate 5.1.

1. *Gymnosperm* tracheid; slide: H-9-2. cross-table number: 15.8/127.7.
2. *Gymnosperm* tracheid transversed by hyphae; slide: H-9-5, cross-table number: 18.4/139.4.
3. *Gymnosperm* tracheid. The areolate pitting is well preserved; slide: H-8-5, cross-table number: 21.4/132.2.
4. *Gymnosperm* tracheid, similar to *Taxaceae* or *Cephalotaxaceae* thickening; slide: H-1-1, cross-table number: 20.2/144.9.
5. *Angiosperm* vessel of *Betulaceae*, origin (*Alnus, Betula*); slide: H-9-2, cross-table number: 10.4/141.6.
6. *Angiosperm* vessel probably of *Salicaceae* origin; slide: H-9-2, cross-table number: 20.4/141.6.

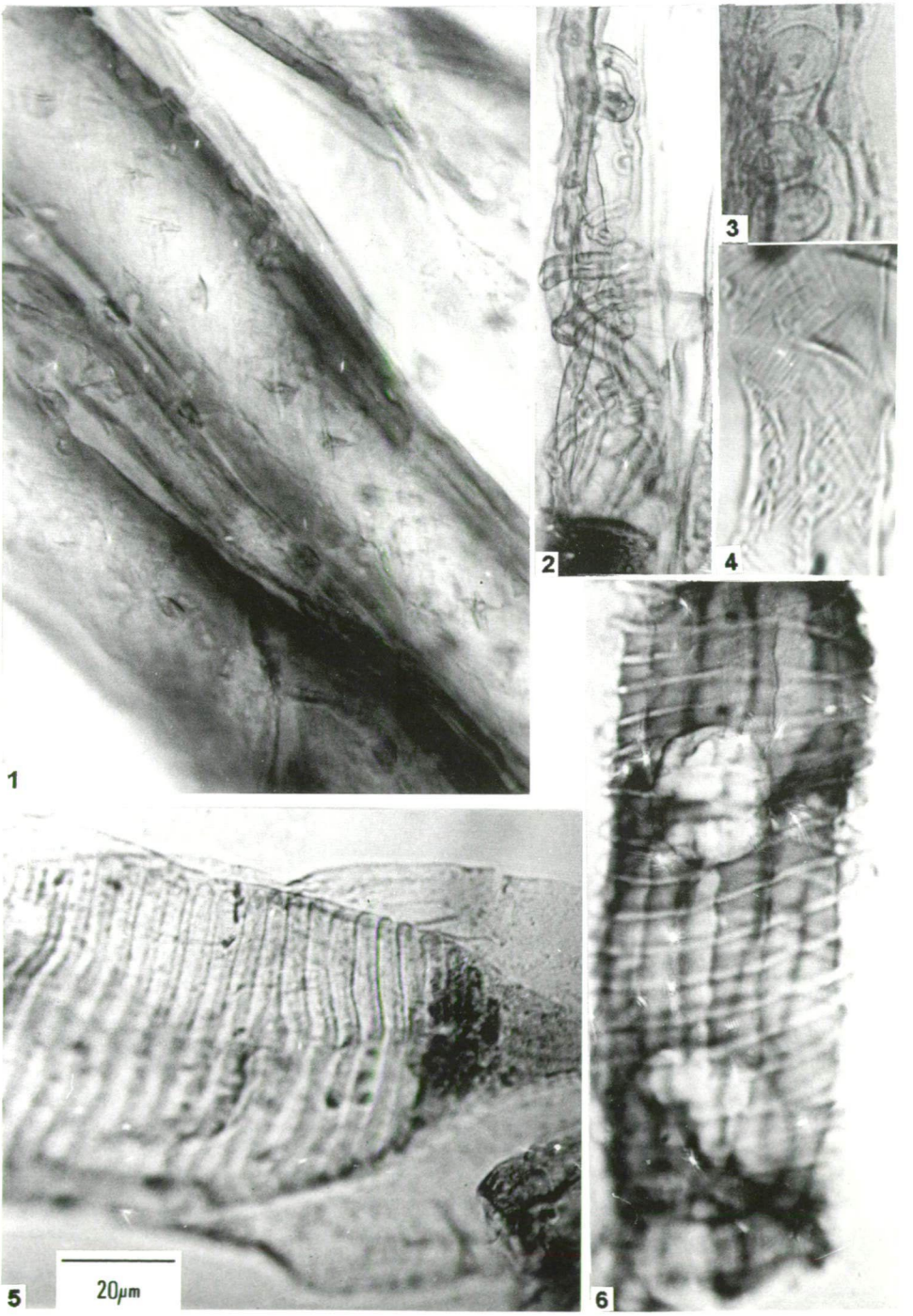

Plate 5.1.

PHYLUM: BRYOPHYTA
CLASSIS: MUSCI
SUBCLASSIS: SPHAGNIDAE

Ordo: *Sphagnales*

Familia: *Sphagnaceae, Sphagnum; Stereisporites (Stereisporites) involutus* (DOKT.-HREBN. 1960) KRUTZSCH 1963b.

PHYLUM: PTERIDOPHYTA
CLASSIS: LYCOPSIDA

Ordo: *Lycopodiales*

Familia: *Lycopodiaceae, Lycopodium; Retitriletes punctoides* KRUTZSCH 1963a.

CLASSIS: PTEROPSIDA
SUBCLASSIS: LEPTOSPORANGIATAE

Ordo: *Osmundales*

Familia: *Osmundaceae, Osmunda; Baculatisporites primarius* (WOLFF 1934) THOMSON et PFLUG 1953 subfsp. *primarius* (Plate 5.2., fig. 2).

Ordo: *Filicales*

Familia: *Polypodiaceae; Laevigatosporites haardti* (POTONIÉ et VENITZ 1934) THOMSON et PFLUG 1953 subfsp. *haardti* (Plate 5.2., fig. 3), *Verrucatosporites tenellis* (KRUTZSCH 1959) KRUTZSCH 1967 (Plate 5.2., fig. 4).

Familia: *Pteridaceae, Pteris; Polypodiaceoisporites gracillimus* E. NAGY 1963b subfsp. *granoverrucatus* KRUTZSCH 1967.

SUBCLASSIS: HYDROPTERIDES

Ordo: *Salviniales*

Familia: *Salviniaceae; Azolla bohemica* PACLTOVÁ 1960 (Plate 5.2., fig. 1), *Azolla* v. *Salvinia*; *Hydrosporis levis* KRUTZSCH 1962.

PHYLUM: GYMNOSPERMATOPHYTA
SUBPHYLUM: PTERIDOSPERMOPHYTINA
CLASSIS: CYCADOPSIDA

Ordo: *Cycadales*

Familia: *Cycadaceae; Cycadopites gracilis* KRUTZSCH 1970a.

SUBPHYLUM: CONIFEROPHYTINA
CLASSIS: CONIFEROPSIDA

Ordo: *Pinales*

Familia: *Abietaceae, Pinus; Pityosporites microalatus* (POTONIÉ 1931b) THOMSON et PFLUG 1953 (Plate 5.2., figs. 5,7), cf. *Cedrus; Cedripites dacrydioides* KRUTZSCH 1971 (Plate 5.2., fig. 6), *Cedripites miocaenicus* KRUTZSCH 1971 (Plate 5.2., fig. 8), *Abies; Abiespollenites absolutus* THIERGART 1938 (Plate 5.2., fig. 9), *Keteleeria* v. *Abies; Abiespollenites maximus* KRUTZSCH 1971 (Plate 5.2., fig. 10), *Abies; Abiespollenites microsaccoides* KRUTZSCH 1971 (Plate 5.2., figs. 11,12), *Picea*; cf. *Piceapollis praemarinus* KRUTZSCH 1971 (Plate 5.3., fig. 1), *Pseudotsuga* v. *Larix; Psophosphaera pseudotsugoides* KRUTZSCH 1971, *Tsuga; Zonalapollenites rueterbergensis* KRUTZSCH 1971 (Plate 5.3., figs. 2,3).

Familia: *Taxodiaceae, Sequoia; Sequoiapollenites polyformosus* THIERGART 1938 (Plate 5.3., fig. 5), *Sequoiapollenites sculpturius* KRUTZSCH 1971 (Plate 5.3., figs. 8-

11), cf. *Glyptostrobus; Inaperturopollenites concedipites* (WODEHOUSE 1933) KRUTZSCH 1971 (Plate 5.3., figs. 6,7).

Familia: *Cupressaceae, Juniperus* type; *Cupressacites* cf. *insulipapillatus* (TREVISAN 1967) KRUTZSCH 1971 (Plate 5.3., fig. 12).

PHYLUM: ANGIOSPERMATOPHYTA
CLASSIS: DICOTYLEDONOPSIDA

Ordo: *Magnoliales*
Familia: *Magnoliaceae; Magnolipollis* cf. *micropunctatus* KRUTZSCH 1970a (Plate 5.3., fig. 4).

Ordo: *Dilleniales*
Familia: *Dipterocarpaceae; Dipterocarpacearumpollenites spinosus* E. NAGY 1969.

Ordo: *Myrtales*
Familia: *Thymelaeaceae; Thymelipollis retisculpturius* KRUTZSCH 1966.
Familia: *Onagraceae; Corsinipollenites oculus-noctis* (THIERGART 1940) NAKOMAN 1965.

Ordo: *Terebinthales*
Familia: *Aceraceae, Acer; Aceripollenites reticulatus* E. NAGY 1969.

Ordo: *Celastrales*
Familia: *Aquifoliaceae, Ilex; Ilexpollenites margaritatus* (POTONIÉ 1931a) THIERGART 1938 f. *medius* PFLUG et THOMSON 1953 (Plate 5.3., fig. 33).

Ordo: *Cornales*
Familia: *Araliaceae* v. *Cornaceae; Araliaceoipollenites euphorii* (POTONIÉ 1931a) POTONIÉ 1960.

Familia: *Umbelliferae; Umbelliferoipollenites* fspp.

Familia: *Nyssaceae; Nyssapollenites* fsp.

Ordo: *Rubiales*
Familia: *Adoxaceae; Retitricolporites nagyae* KEDVES 1978.

Ordo: *Malvales*
Familia: *Tiliaceae, Tilia; Intratriporopollenites insculptus* MAI 1961.

Ordo: *Ligustrales*
Familia: *Oleaceae, Fraxinus* type.

Ordo: *Asterales*
Familia: *Compositae, Tubuliflorae; Tubulifloridites* fsp., *Liguliflorae, Cichoreacidites gracilis* (E. NAGY 1969) n. comb. syn.: *Cichoriaearumpollenites gracilis* n.g. n.sp.

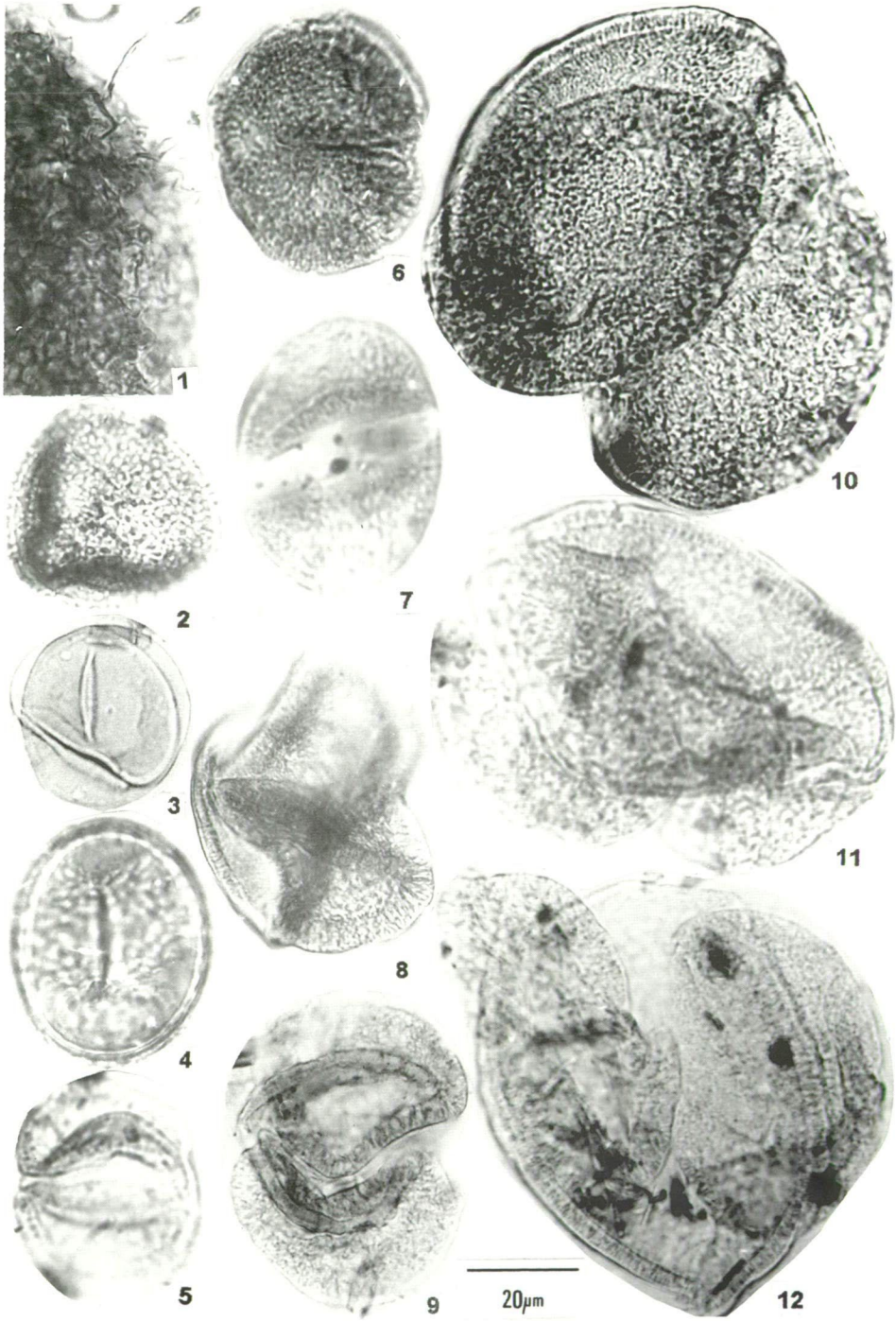

Plate 5.2.

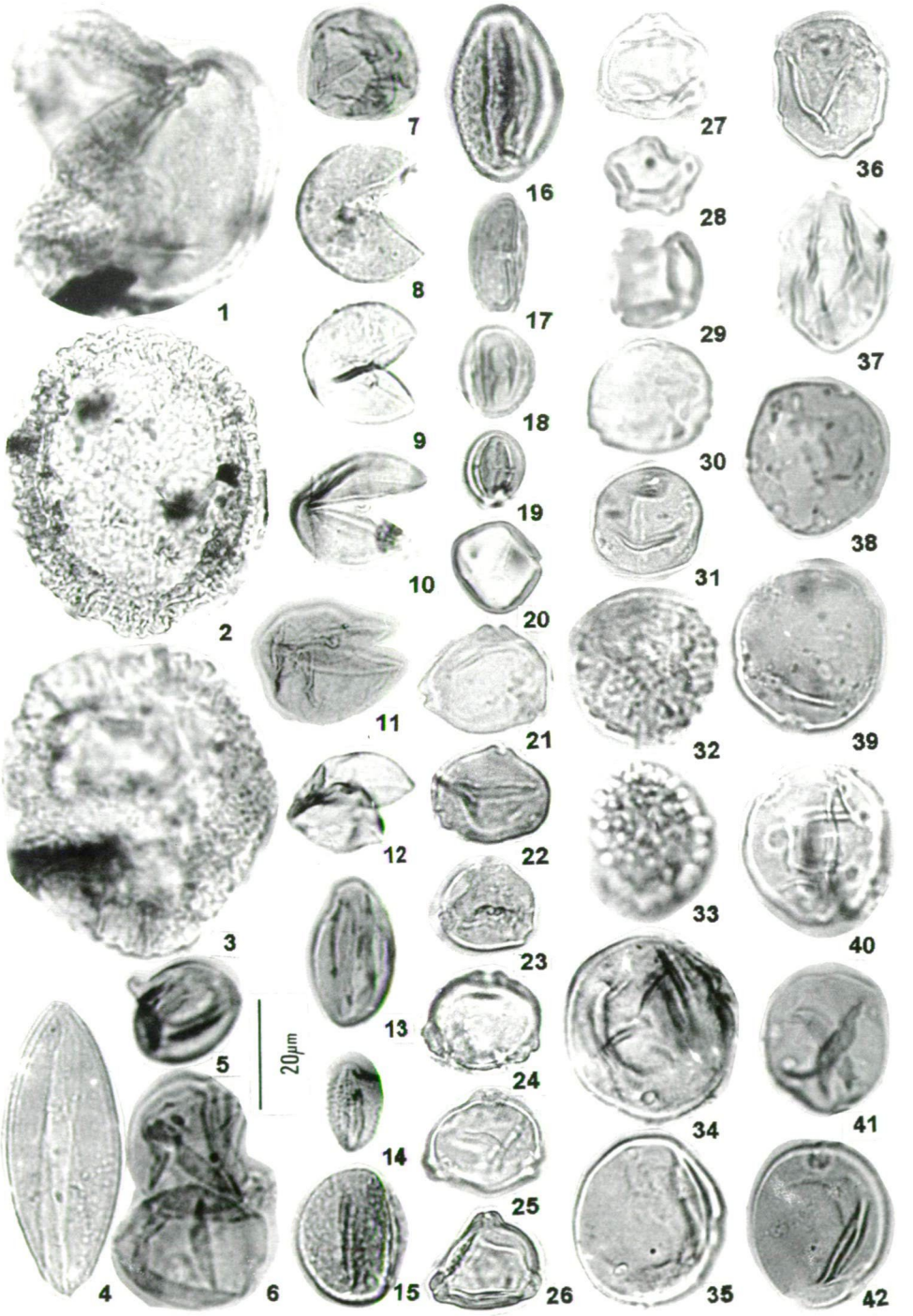
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Plate 5.3.

Ordo: *Ericales*
Familia: *Ericaceae; Ericipites callidus* (POTONIÉ 1931a) KRUTZSCH 1970b.
Familia: *Cyrillaceae*; cf. *Cyrillaceaepollenites* fsp. (Plate 5.3., fig. 20).

Ordo: *Caryophyllales*
Familia: *Chenopodiaceae; Chenopodiipollis psilatoides* (TREVISAN 1967) KEDVES 1981, *Ch. microforaminatus* (TREVISAN 1967) KEDVES 1981.

Ordo: *Ebenales*
Familia: *Sapotaceae; Tetracolporopollenites biconus* PFLUG 1953.

Ordo: *Polygonales*
Familia: *Polygonaceae, Polygonum persicaria* type; *Persicarioipollis minor* KRUTZSCH 1962, *Persicarioipollis crassicus* KRUTZSCH 1962.

Plate 5.2.

1. *Azolla bohemica* PACLTOVÁ 1960, *Azolla* v. *Salvinia*; slide: H-1-5, cross-table number: 19.4/126.3.
2. *Baculatisporites primarius* (WOLFF 1934) THOMSON et PFLUG 1953 subfsp. *primarius, Osmundaceae, Osmunda*; slide: H-1-5, cross-table number: 12.4/153.7.
3. *Laevigatosporites haardti* (POTONIÉ et VENITZ 1934), THOMSON et PFLUG 1953 subfsp. *haardti Polypodiaceae*; slide: H-9-2, cross-table number: 12.6/135.3.
4. *Verrucatosporites tenellis* (KRUTZSCH 1959) KRUTZSCH 1967c, *Polypodiaceae*; slide: H-10-1, cross-table number: 26.2/144.2.
5. *Pityosporites microalatus* (POTONIÉ 1931b) THOMSON et PFLUG 1953 *Abietaceae, Pinus*; slide: H-1-2, cross-table number: 19.3/147.2.
6. *Cedripites dacrydioides* KRUTZSCH 1971, cf. *Cedrus*; slide: H-10-2, cross-table number: 22.9/135.5.
7. *Pityosporites microalatus* (POTONIÉ 1931b) THOMSON et PFLUG 1953, *Abietaceae, Pinus*; slide: H-1-4, cross-table number: 23.5/119.6.
8. *Cedripites miocaenicus* KRUTZSCH 1971, cf. *Cedrus*; slide: H-1-5, cross-table number: 7.6/137.6.
9. *Abiespollenites absolutus* THIERGART 1938, *Abietaceae, Abies*; slide: H-1-5, cross-table number: 24.2/135.2.
10. *Abiespollenites maximus* KRUTZSCH 1971, *Abietaceae, Keteleeria* v. *Abies*; slide: H-10-4, cross-table number: 15.3/139.8.
11. *Abiespollenites microsaccoides* KRUTZSCH 1971, *Abietaceae, Abies*; slide: H-1-2, cross-table number: 8.4/142.2.
12. *Abiespollenites microsaccoides* KRUTZSCH 1971, *Abietaceae, Abies*; slide: H-1-1, cross-table number: 23.3/150.4.

Plate 5.3.

1. Cf. *Piceapollis praemarinus* KRUTZSCH 1971, *Abietaceae, Picea;* slide: H-1-2, cross-table number: 6.3/148.1.
2. *Zonalapollenites rueterbergensis* KRUTZSCH 1971, *Abietaceae, Tsuga*; slide: H-1-5, cross-table number: 8.2/145.5.
3. *Zonalapollenites rueterbergensis* KRUTZSCH 1971, *Abietaceae, Tsuga*; slide: H-1-4, cross-table number: 20.8/120.7.
4. *Magnolipollis* cf. *micropunctatus* KRUTZSCH 1970, *Magnoliaceae*; slide: H-3-1, cross-table number: 17.2/142.4.
5. *Sequoiapollenites polyformosus* THIERGART 1938, *Taxodiaceae, Sequoia*; slide: H-3-4, cross-table number: 17.4/138.8.
6. *Inaperturopollenites concedipites* (WODEHOUSE 1933) KRUTZSCH 1971, *Taxodiaceae*, cf. *Glyptostrobus*; slide: H-7-3, cross-table number: 13.8/130.7.
7. *Inaperturopollenites concedipites* (WODEHOUSE 1933) KRUTZSCH 1971, *Taxodiaceae*, cf. *Glyptostrobus*; slide: H-1-1, cross-table number: 22.6/154.2.

8. *Sequoiapollenites sculpturius* KRUTZSCH 1971, *Taxodiaceae, Sequoia*; slide: H-10-4, cross-table number: 20.7/141.2.
9. *Sequoiapollenites sculpturius* KRUTZSCH 1971, *Taxodiaceae, Sequoia*; slide: H-10-4, cross-table number: 20.5/142.3.
10. *Sequoiapollenites sculpturius* KRUTZSCH 1971, *Taxodiaceae, Sequoia*; slide: H-1-5, cross-table number: 14.2/141.3.
11. *Sequoiapollenites sculpturius* KRUTZSCH 1971, *Taxodiaceae, Sequoia*; slide: H-1-1, cross-table number: 20.9/137.4.
12. *Cupressacites* cf. *insulipapillatus* (TREVISAN 1967) KRUTZSCH 1971; *Cupressaceae Juniperus* type; slide: H-1-1, cross-table number: 12.1/139.2.
13. *Salixipollenites* fsp., *Salicaceae Salix*; slide: H-7-3, cross-table number: 10.1/138.3.
14. *Salixipollenites helveticus* E. NAGY 1969, *Salicaceae, Salix*; slide: H-1-1, cross-table number: 0.9/145.3.
15. *Quercopollenites granulatus* E. NAGY 1969, *Fagaceae, Quercus*; slide: H-10-4, cross-table number: 11.6/139.7.
16. *Tricolporopollenites microhenrici* (POTONIÉ 1931a) KRUTZSCH 1961 subfsp. *intragranulatus* PFLUG 1953a; slide: H-8-5, cross-table number: 16.4/133.9.
17. *Cupuliferoipollenites pusillus* (POTONIÉ 1934) POTONIÉ 1960, *Fagaceae, Castaneoid* type; slide: H-3-1, cross-table number: 15.2/145.4.
18. *Cupuliferoipollenites oviformis* (POTONIÉ 1931a) POTONIÉ 1960, *Fagaceae, Castaneoid* type; slide: H-7-2, cross-table number: 7.1/130.1.
19. *Cupuliferoipollenites oviformis* (POTONIÉ 1931a) POTONIÉ 1960, *Fagaceae, Castaneoid* type; slide: H-1-1, cross-table number: 15.3/146.9.
20. Cf. *Cyrillaceaepollenites* fsp., *Cyrillaceae*; slide: H-1-1, cross-table number: 22.6/154.2.
21. *Labraferoidaepollenites menatensis* KEDVES 1982 in KEDVES and RUSSELL, *Myricaceae*; slide: H-4-3, cross-table number: 19.3/141.5.
22. *Labraferoidaepollenites menatensis* KEDVES 1982 in KEDVES and RUSSELL, *Myricaceae*; slide: H-8-5, cross-table number: 9.6/134.2.
23. *Plicatopollis* fsp., *Juglandaceae*; slide: H-6-1, cross-table number: 15.3/144.2.
24. *Betulaepollenites betuloides* (PFLUG 1953) E. NAGY 1969, *Betulaceae, Betula*; slide: H-6-1, cross-table number: 16.3/140.2.
25. *Betulaepollenite betuloides* (PFLUG 1953) E. NAGY 1969, *Betulaceae, Betula*; slide: H-4-2, cross-table number: 20.4/136.3.
26. *Betulaepollenites betuloides* (PFLUG 1953) E. NAGY 1969, *Betulaceae, Betula*; slide: H-6-1, cross-table number: 9.6/141.2.
27. *Betulaepollenites betuloides* (PFLUG 1953) E. NAGY 1969, *Betulaceae, Betula*; slide: H-4-5, cross-table number: 15.7/142.3.
28. *Alnipollenites verus* POTONIÉ 1934, *Betulaceae, Alnus*; slide: H-7-5, cross-table number: 7.9/137.5.
29. *Alnipollenites verus* POTONIÉ 1934, *Betulaceae, Alnus*; slide: H-1-2, cross-table number: 9.7/146.1.
30. *Ostryapollenites rhenanus* (THOMSON 1950) E. NAGY 1969, *Betulaceae, Ostrya*; slide: H-2-1, cross-table number: 8.6/138.3.
31. *Ostryapollenites rhenanus* (THOMSON 1950) E. NAGY 1969, *Betulaceae, Ostrya*; slide: H-5-1, cross-table number: 16.3/137.7.
32. *Ulmipollenites stillatus* E. NAGY 1969, *Ulmaceae, Ulmus*; slide: H-6-1, cross-table number: 20.6/141.5.
33. *Ilexpollenites margaritatus* (POTONIÉ 1931a) THIERGART 1938 *f. medius* PFLUG et THOMSON 1953, *Aquifoliaceae, Ilex*; slide: H-10-1, cross-table number: 19.3/147.6.
34. *Caryapollenites simplex* (POTONIÉ 1931b) POTONIÉ 1960, *Juglandaceae, Carya*; slide: H-10-3, cross-table number: 7.9/129.3.
35. *Caryapollenites simplex* (POTONIÉ 1931b) POTONIÉ 1960, *Juglandaceae, Carya*; slide: H-10-4, cross-table number: 9.8/135.9.
36. *Pterocaryapollenites* fsp., *Juglandaceae, Pterocarya*; slide: H-6-1, cross-table number: 10.7/146.9.
37. *Pterocaryapollenites* fsp., *Juglandaceae, Pterocarya*; slide: H-7-2, cross-table number: 10.8/141.2.
38. *Juglanspollenites verus* RAATZ 1937, *Juglandaceae, Juglans*; slide: H-10-1, cross-table number: 13.6/138.5.
39. *Celtipollenites komloensis* E. NAGY 1969, *Ulmaceae, Celtidoideae, Celtis*; slide: H-10-1, cross-table number: 19.3/146.7.
40. *Celtipollenites komloensis* E. NAGY 1969, *Ulmaceae, Celtidoideae, Celtis*; slide: H-1-2, cross-table number: 15.3/155.6.
41. *Celtipollenites komloensis* E. NAGY 1969, *Ulmaceae, Celtidoideae, Celtis*; slide: H-7-4, cross-table number: 12.3/142.5.
42. *Celtipollenites komloensis* E. NAGY 1969, *Ulmaceae, Celtidoideae, Celtis*; slide: H-10-4, cross-table number: 20.5/137.9.

Ordo: *Urticales*

Familia: *Urticaceae; Triporopollenites urticoides* E. NAGY 1969.

Familia: *Ulmaceae, Ulmoideae, Ulmus; Ulmipollenites undulosus* WOLFF 1934, *U. stillatus* E. NAGY 1969 (Plate 5.3., fig. 32), *Zelkova, Zelkovaepollenites thiergarti* E. NAGY 1969, Concerning the identification of the *Ulmus* and *Zelkova* pollen MORITA, FUJIKI, KATAOKA and MIYOSHI (1988) established that the pollen grains of the two genuses may be distinguishable by LM method on the basis of shape and structure. Pollen grains of *Zelkova* has thicker annulus and exine, and coarser sculpture than that of *Ulmus. Celtidoideae, Celtis, Celtipollenites komloensis* E. NAGY 1969 (Plate 5.3., figs. 39-42).

Ordo: *Fagales*

Familia: *Betulaceae, Corylus; Triporopollenites coryloides* PFLUG 1953, *Betula; Betulaepollenites betuloides* (PFLUG 1953) E. NAGY 1969 (Plate 5.3., figs. 24-27), *Alnus; Alnipollenites verus* POTONIÉ 1934 (Plate 5.3., figs. 28,29), *Carpinus; Carpinuspollenites carpinoides* (PFLUG 1953) E. NAGY 1969, *Ostrya; Ostryapollenites rhenanus* (THOMSON 1950) E. NAGY 1969 (Plate 5.3., figs. 30, 31).

Familia: *Fagaceae, Quercus; Quercopollenites granulatus* E. NAGY 1969 (Plate 5.3., fig. 15), *Tricolporopollenites microhenrici* (POTONIÉ 1931a) KRUTZSCH 1961 subfsp. *intragranulatus* (Plate 5.3., fig. 16), *Castaneoid* type; *Cupuliferoipollenites oviformis* (POTONIÉ 1931a) POTONIÉ 1960 (Plate 5.3., figs. 18,19), *C. pusillus* (POTONIÉ 1934) POTONIÉ 1960 (Plate 5.3., fig. 17), cf. *Castanopsis; Fususpollenites fusus* (POTONIÉ 1934) KEDVES 1978.

Ordo: *Juglandales*

Familia: *Juglandaceae, Carya; Caryapollenites simplex* (POTONIÉ 1931b) POTONIÉ 1960 (Plate 5.3., figs. 34,35), *Pterocarya; Pterocaryapollenites* fsp. (Plate 5.3., figs. 36, 37), *Juglans; Juglanspollenites verus* RAATZ 1937 (Plate 5.3., fig. 38), *Engelhardtia* type; *Plicatopollis fsp.* (Plate 5.3., fig. 23).

Ordo: *Myricales*

Familia: *Myricaceae, Labraferoidaepollenites rurensis* (PFLUG et THOMSON 1953) KEDVES et RUSSELL 1982, *L. menatensis* KEDVES 1982, in KEDVES and RUSSELL (Plate 5.3., figs. 21,22), *Alabroidaepollenites myricoides* (KREMP 1949) KEDVES 1982, in KEDVES and RUSSELL.

Ordo: *Salicales*

Familia: *Salicaceae, Salix; Salixipollenites helveticus* E. NAGY 1969 (Plate 5.3., fig. 14),

Salixipollenites fsp. (Plate 5.3., fig. 13).

Classis: MONOCOTYLEDONOPSIDA

Ordo: *Cyperales*

Familia: *Cyperaceae; Cyperaceaepollis neogenicus* KRUTZSCH 1970a.

Ordo: *Poales*

Familia: *Poaceae; Graminidites laevigatus* KRUTZSCH 1970a.

Ordo: *Spadiciflorae*

Familia: *Palmae; Monocolpopollenites* cf. *tranquillus* (POTONIÉ 1934) THOMSON et PFLUG 1953.

Ordo: *Dioscoreales* v. *Hydrocharitales, Smilax* v. *Hydrocharis; Monogemmites pseudosetarius* (WEYLAND et PFLUG 1957) KRUTZSCH 1970a. PLANDEROVÁ (1990) published this form-species as *Nymphaeaepollenites pseudosetarius* (W. KR. 1970a) n. comb., with the *Nymphaeaceae* botanical affinity.

Mycophyta and microplancton remnants

Mycophyta

Fungal cell indet. (Plate 5.4., fig. 2). This remnant is identical with those published by RÜFFLE (1963), as "Unbestimmtbare Hyphenstücke RM 014", Plate XVI, fig. 6.

Pyrrhophyta

Dinoflagellatae

Rhombodinium cf. *draco* GOCHT 1955 (Plate 5.4., fig. 1).

Catillopsis abdita DRUGG 1970 (Plate 5.4., figs. 3-6). Great morphological variation within this species was observed. Some are illustrated.

Quantitative data

Miocene

Bükkábrány, lignite mine

1. Sample No: H-16
   Abundant or common sporomorphs (10%, or over)
   Taxodiaceae-Cupressaceae (33.9%)
   Pinus (15.5%)
   Betula (16.3%)

Additional elements: *Osmunda, Polypodiaceae (L. haardti), Pinus, Picea, Abies, Keteleeria, Castaneoid* group, *Salix, Celtis, Myricaceae, Carya, Chenopodiaceae, Gramineae, Tilia, Cyrillaceae, Engelhardtia.*

Taxodiaceae-Cupressaceae swamp, followed by *Betulaceae (Alnus, Betula)* zone on the basis of the palynological data: The relatively high quantity of *Pinus* pollen grains indicate the nearness of the open swamp.

2. Sample No: H-17
   Abundant or common elements (10%, or over)
   Polypodiaceae (L. haardti) (30.8%)
   Taxodiaceae-Cupressaceae (23.0%)
   Alnus (13.0%)
   Pollen grains of 5%, or over
   Pinus (7.3%)
   Salix (5.4%)
   Celtis (5.0%)

Additional elements: *Osmunda, Cycadopites, Cedrus, Palmae, Monogemmites pseudosetarius, Castaneoid* group, *Ulmus/Zelkova, Acer, Betula, Myricaceae, Carya, Engelhardtia, Urtica, Cyperaceae, Ostrya.*

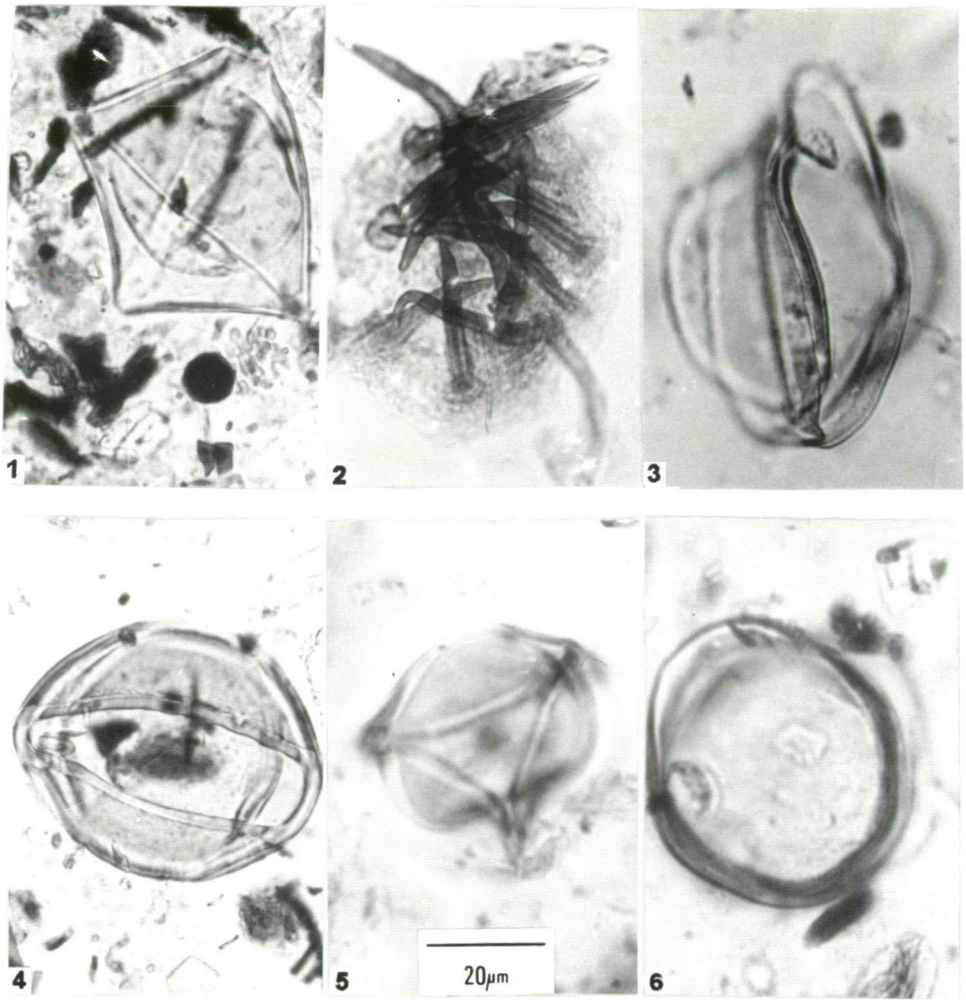

Plate 5.4.

1. *Rhombodinium* cf. *draco* GOCHT 1955; slide: H-1-5, cross-table number: 6.9/123.7.
2. Fungal cell indet.; slide: H-2-3, cross-table number: 5.6/135.8.
3. *Catillopsis abdita* DRUGG 1970; slide: H-1-1, cross-table number: 20.7/143.9.
4. *Catillopsis abdita* DRUGG 1970; slide: H-1-2, cross-table number: 17.3/147.6.
5. *Catillopsis abdita* DRUGG 1970; slide: H-1-4, cross-table number: 9.4/114.1.
6. *Catillopsis abdita* DRUGG 1970; slide: H-1-5, cross-table number: 13.5/155.9.

The high quantity of *Polypodiaceae* spores may be emphasized. *Pteridophyta - Taxodiaceae-Cupressaceae,* and mixed decidous forest (*Alnus, Salix, Celtis*) zones may be reconstructed.

3. Sample No: H-20
   Abundant or common elements (10%, or over)

Pinus (22.5%)
Taxodiaceae-Cupressaceae (38.7%)
Pollen grains over 5%
Castaneoid group (7.7%)
Salix (5.5%)
Alnus (6.3%)

Additional elements: *Osmunda, Cycadopites, Ulmus/Zelkova, Celtis, Thymelipollis, Betula, Myricaceae, Pterocarya, Carya, Engelhardtia, Urtica.*

Open swamp - *Taxodiaceae-Cupressaceae*, and mixed decidous zones may be reconstructed on the basis of the palynological data.

4. Sample No: H-28
Abundant or common elements (10%, or over)
Taxodiaceae-Cupressaceae (67.6%)
Pollen grains of 5%, or over
Pinus (5.4%)
Castaneoid group (5.0%)
Salix (5.0%)

Additional elements: *Osmunda, Polypodiaceae (L. haardti), Cycadopites, Picea, Abies, Keteleeria, Palmae, Ulmus/Zelkova, Celtis, Tubulifloridites, Alnus, Myricaceae, Umbelliferae.*

Very characteristic *Taxodiaceae-Cupressaceae* swamp forest may be presumed based on this palynological composition.

Upper Pliocene

Tihany Formation

This formation was investigated from two localities:
1. Szombathely, bore-hole II, 712.0-712.7 m
1.1. Abundant or common sporomorphs (10%, or over)
Taxodiaceae-Cupressaceae (10.0%)
Salix (10.62%)
Alnus (25.5%)
1.2. Pollen grains over 5%
Ulmus/Zelkova (5.5%)
1.3. Additional elements: *Osmunda, Pteridaceae, Polypodiaceae, Pinus, Picea, Abies, Keteleeria, Monogemmites pseudosetarius, Castaneoid* group, *Thymelipollis, Cichoreacidites, Betula, Carpinus, Ostrya, Carya, Onagraceae, Polygonum, Adoxaceae, Dipterocarpaceae, Corylus, Plicatopollis.*

A mixed swamp forest may be presumed. *Taxodiaceae-Cupressaceae* swamp, *Myricaceae, Alnus, Salix* zone. The quantity of *Ulmus* and *Zelkova* pollen grains is also worth of mentioning.

2. Iharosberény, sample No: 78 (130.1-130.3 m)
2.1. Abundant or common sporomorphs (10%, or over)
Taxodiaceae-Cupressaceae (50.8%)
Myricaceae (16.8%)

Based on the abundant pollen grains a *Taxodiaceae-Cupressaceae* swamp forest and a *Myricaceae* shrub vegetation formed the lignite layers.

2.2. Pollen grains over 5%
Alnus (9.4%)
Carya (5.1%)

2.3. Additional elements: *Osmunda, Polypodiaceae, Pinus, Picea, Abies, Keteleeria, Palmae, Quercus, Castaneoid* group, *Nyssaceae, Ilex, Sapotaceae, Ulmus/Zelkova, Celtis, Betula, Ericaceae, Pterocarya, Juglans, Gramineae.*

2.4. In this sample more or less well preserved secondary wood fragments were observed: spirally thickened tracheids (*Taxaceae, Cephalotaxaceae*, etc.), bordered pitting of degraded tracheids, cross fields with pinoide pitting. *Angiosperm*, probably *Betulaceae* vessel, *Salicaceae* woody fragment.

Taxodiaceae-Cupressaceae swamp forest, followed by *Myricaceae* shrubs. Mixed zone with *Alnus, Carya*, and other decidous elements may also be presumed.

Torony Formation
Szombathely, bore-hole II, 189.5-189.7 m
Abundant or common sporomorphs (10%, or over)
Castaneoid group (10.5%)
Salix (10.5%)
Alnus (13.8%)
Sporomorphs over 5%
Polypodiaceae (L. haardti) (6.0%)
Pinus (6.6 %)
Larix (6.0%)
Taxodiaceae-Cupressaceae (8.4%)
Monogemmites pseudosetarius (5.1%)
Ulmus/Zelkova (7.8%)

Additional elements: *Azolla, Hydrosporis, Stereisporites, Lycopodium, Pteridaceae, Cycadopites, Picea, Abies, Keteleeria, Cedrus, Tsuga, Araliaceae, Quercus, Sapotaceae, Celtis, Acer, Tubulifloridites, Betula, Myricaceae, Ericaceae, Carya, Chenopodiaceae, Polygonum, Gramineae.*

This spore-pollen assemblage refers to an open swamp near a mixed forest zone.

Tiszapalkonya, bore-hole I

1. Sample No: TK-I-10 (401.9-402.3 m)
1.1. Dominant or common elements (10%, or over)
Taxodiaceae-Cupressaceae (17.8%)
Celtis (36.9%)
1.2. Pollen grains of 5%, or over
Polypodiaceae (L. haardti) (5.0%)
Picea, Abies, Keteleeria (6.4%)
Castaneoid group (6.0%)
Alnus (8.0%)
1.3. Additional elements: *Sphagnum, Osmunda, Polypodiaceae (Verrucatosporites), Pinus, Cedrus, Tsuga, Monogemmites pseudosetarius, Quercus, Salix, Ulmus/Zelkova, Betula, Myricaceae, Carya, Polygonum, Tilia, Umbelliferae, Cyrillaceae, Cyperaceae, Fraxinus.*

The dominance of *Celtis* pollen grains is interesting. *Taxodiaceae-Cupressaceae* swamp forest with decidous forest may be presumed with *Celtis, Alnus* and *Castaneoid* types.

2. Sample No: TK-I-9 (519.7-519.9 m)
2.1. Dominant or common elements (10%, or over)
Polypodiaceae (L. haardti) (11.3%)
Taxodiaceae-Cupressaceae (40.0%)
Alnus (21.0%)
2.2. Pollen grains over 5%
Picea, Abies, Keteleeria (5.3%)
2.3. Additional elements: *Sphagnum, Osmunda, Cycadopites, Pinus, Cedrus, Monogemmites pseudosetarius, Quercus, Castaneoid* group, *Salix, Ulmus/Zelkova, Celtis, Acer, Betula, Myricaceae, Carya, Chenopodiaceae.*

Taxodiaceae-Cupressaceae - *Alnus* swamp forest zonation is represented by the palynological data, with the high quantity of *Pteridophyta* spores.

3. Sample No: TK-I-8 (1217.8-1218.3 m)
3.1. Dominant or common elements (10%, or over)
Taxodiaceae-Cupressaceae (36.1%)
Celtis (12.5%)
Alnus (13.25)
3.2. Pollen grains over 5%
Pinus (5.9%)
Quercus (9.6%)
Castaneoid group (8.1%)
Salix (6.6%)
3.3. Additional elements: *Osmunda, Cycadopites, Cedrus, Larix, Carya, Chenopodiaceae, Cyrillaceae, Engelhardtia.*

Taxodiaceae-Cupressaceae and mixed decidous zone characterized by *Alnus, Celtis, Salix, Quercus* may be reconstructed.

Discussion and Conclusions

As to the paleobotanical and paleoecological interpretation of the spore-pollen data the publications of TEICHMÜLLER (1958) and the papers from the Neogene of Polish Lowlands (WAŻYŃSKA, PIWOCKI, ZIEMBIŃSKA-TWORZYDŁO, GRABOWSKA, KOHLMAN-ADAMSKA, SŁODKOWSKA and STUCHLIK, 1998) apart of the establishments on the Hungarian layers were used.

Miocene

Bükkábrány lignite mine

The vegetation types of the lignite layers forming vegetation at the investigated samples are different. In this place the high quantity (22.5%) of the *Pinus*, and 38.0% of the *Taxodiaceae-Cupressaceae* pollen grains in the sample H-20 indicate a deep swamp which was followed a mixed *Salix* and *Alnus* decidous zone. Sample H-16 is a little

similar but with a *Betula* and *Alnus* decidous zone. The very high quantity of the *Polypodiaceae* spores (30.8%) in the sample H-17 with 23.0% of *Taxodiaceae-Cupressaceae* pollen grains represent another type of riparian or swamp forest, with *Alnus, Salix* and *Celtis* mixed forest. Sample H-28 based on the spore-pollen data was formed from a typically *Taxodiaceae-Cupressaceae* swamp forest.

In comparison to the spore-pollen data isolated from Miocene sediments we can point out the relatively low quantity of the *Myricaceae* pollen grains, and in some places the important quantity of the pollen grains of *Betula, Alnus* and *Salix*.

Upper Pliocene

Tihany Formation

Locality: Szombathely

In the first place a decidous forest may be reconstructed with *Salix, Alnus, Ulmus/Zelkova* woods and *Myricaceae* shrubs, on the basis of the palynological data forming the lignite layers. The quantity of the *Taxodiaceae-Cupressaceae* pollen grains is relatively low, in contrast to the following locality:

Iharosberény. At this sample a *Taxodiaceae-Cupressaceae* swamp forest followed a *Myricaceae* zone with *Alnus* and *Carya* may be reconstructed.

Finally the paleoecological conditions, and in consequence of this the lignite layers forming vegetation were different at the two localities of this formation.

Torony Formation

Locality: Szombathely

This formation was investigated from one locality only. An interesting open or deep swamp may be reconstructed on the basis of the palynological data. The vegetation around the sedimentary basin was a mixed *gymnosperm* and decidous *angiosperm* woods.

Tiszapalkonya

At the sample TK-I-10 the high quantity (36.9%) of the pollen grains of the genus *Celtis* may be emphasized. It is interesting that in the Neogene of the Polish Lowlands the VIII climatic phase - *Celtipollenites verus* spore-pollen zone is in the Middle Miocene (ZIEMBIŃSKA-TWORZYDŁO,1998, in: WAŻYŃSKA). *Taxodiaceae-Cupressaceae - Alnus* zonation may be reconstructed on the basis of the spore-pollen data of the sample TK-I-9. Similar is the zonation of the sample TK-I-8, but the decidous forest is a mixed *Alnus/Celtis* association.

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6. COMBINED INVESTIGATIONS ON HUNGARIAN NEOGENE LIGNITES

M. KEDVES[1], M. SZÓNOKY[2] and S. GULYÁS[2]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary, 2. Department of Geology and Paleontology of the J.A. University, H-6701, P.O. Box 658, Szeged, Hungary

Abstract

Wood anatomical and palynological investigations were carried out on the samples of the Upper Pliocene of Bátaszék. The embedding sediment of the fossilized woody remnants is rich in sporomorphs, mostly in *gymnosperm* pollen grains of *Pinus, Picea* and/or *Abies* type. The observed organic microplancton taxa are in general reworked from Mesozoic (Jurassic, and/or Cretaceous) sediments. Several xylem remnants were also observed in the embedding sediment, in different kind of preservation. *Sequoioxylon gypsaceum, Sequoioxylon/Cupressinoxylon* and a *dicotyledonous* vessel fragment was identified. Six woody remnants were anatomically investigated. All are *gymnosperms*: Cf. *Taxodiaceae, Glyptostroboxylon* sp., *Taxodioxylon distichoides* HUARD 1966, *Taxodioxylon taxodii* GOTHAN 1905, *Cupressinoxylon secretiferum* GREGUSS 1967, *Cupressinoxylon cf. secretiferum* GREGUSS 1967.

Key words: Fossil wood anatomy, Palynology, Pannonian, Bátaszék, Hungary.

Introduction

The paleontological and paleobotanical findings were the subject of several previous investigations. Wood anatomy and experimental ultrastructure studies were carried out on lignite samples from Bátaszék (KEDVES, 1999, KEDVES and PÁRDUTZ, 2000).

Previously multidisciplinary investigations were made by LENNERT, SZÓNOKY, GULYÁS, SZUROMI-KORECZ, SHATILOVA, SÜTÖ-SZENTAI, GEARY and MAGYAR (1999). Fossil woods were collected by S. GULYÁS. The LM anatomy and the palynological investigations of the xylem remnants embedding layers including the woody fragments are the subjects of this contribution.

The aim of this paper is a short review on the most important paleontological results of the Lake Pannon of Bátaszék and the description and evaluations of the new data.

These investigations constitute a part of the International Geosphere-Biosphere Programme: A Study of Global Change (IGBP); B. Techniques for Extracting Environmental Data of the Past, 16.

Materials and Methods

The material for our investigations was collected by S. GULYÁS, on the 14.08.1998 in Bátaszék, from the bluish-grey silt. Six lignite samples were the subject of wood anatomical studies. Thin sections, and thin slides were made and investigated with the LM method. One embedding sample was treated for palynological study. The sample was treated with the HCl and HF method. The organic residues were mounted in glycerine-jelly hydrated at 39.6%. The woody fragments and the spores and pollen grains were also investigated in the palynological slides. The quantitative data of the sporo-

morphs were suitable to reconstruct the environmental vegetation of the sedimentary basin and the presumed reworking from older layers.

Results

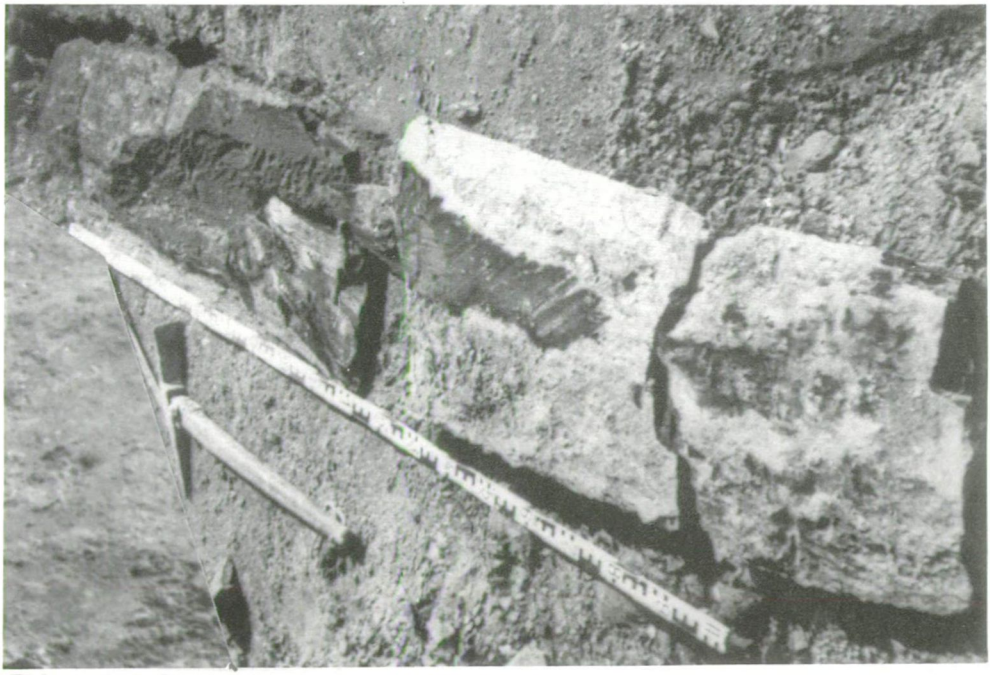
1. The most important previous paleontological data of the Lake Pannon of the Bátaszék brickyard

Based on the paper of LENNERT et al. (1999) we cite the following:

P. 69: "From the Bátaszék outcrop we identified 51 mollusk species (25 bivalve and 26 gastropod), with about 4000 individuals. Shells from the gray silt were usually in good condition, sometimes even with the nacreous layer preserved (especially in *Lymnocardium majeri*). In layer 21, *Lymnocardium* shells were articulated (closed or open), whereas *Congeria* shells were either articulated or disarticulated. We regard the shells of the clayey silt as mostly autochtonous."

P. 74: "The Bátaszék Mollusk fauna is very similar to the classic Szekszárd fauna of LŐRENTHEY (1894) and Okrugljak (Zagreb) fauna of BRUSINA (1884). The Bátaszék fauna is also very similar to the fauna of Jazovnik (Kosarlija valley), a facies stratotype of the "Lower Portaferrian" in western Serbia (STEVANOVIC 1951, 1990).

P. 75: "The Bátaszék outcrop belongs to the sublittoral *Congeria rhomboidea* Zone. A probably transported specimen of *Prosodacnomya* sp. establishes the correlation with the littoral *Prosodacnomya* Zone. *Dinoflagellates* indicate the lower part of the *Galeacysta etrusca* Zone (it corresponds to the "*Spiniferites tihanyensis* Zone" of SÜTŐ-SZENTAI 1994; see SÜTŐ-SZENTAI, 1995). The *ostracod* fauna corresponds to the "Portaferrian" fauna of KRSTIC (1990)."



Text-fig. 6.1.

2. Wood anatomy of the investigated lignite samples

One sample from a large trunk (Text-fig. 6.1.) and five further small pieces were the subjects of our wood anatomical studies. The LM results may be summarized short as follows:

Sample No. 1 : Cf. *Taxodiaceae* (Plate 6.1., figs. 1-4)

The preservation of the secondary wood of this sample is very poor. The cross section (Plate 6.1., fig. 1) well illustrates the compressed and degraded tracheids. The structure of the late wood is in some places perceptible only in some places. The ray is uniseriate and 1-4 cells high (Plate 6.1., fig. 2). The areolate pits of the radial wall of the tracheids are uniseriate (Plate 6.1., fig. 3). The cross field pits are perceptible only in the late wood of taxodioid character (Plate 6.1., fig. 4).

Remark. - Similar preservation was published by SÁRKÁNY (1943) (Plate XLV, fig. 2) from the Miocene lignite of Várpalota.

Sample No. 2 : *Glyptostroboxylon* sp. (Plate 6.2., figs. 1-4)

The degradation of the compressed secondary wood structure is well illustrated in the picture of Plate 6.2., fig. 1. The late wood is about 5-7 tracheids broad. The fossil resin containing parenchym cells is well shown in the early and the late wood alike. The uniseriate rays in the tangential sections are about 1-6 cells high (Plate 6.2., fig. 2). The horizontal wall of the resin containing longitudinal parenchym cells is knottedly thickened (Plate 6.2., fig. 3). There are generaly two or three thickenings. The pitting of the cross fields is glyptostroboide type (cf. GREGUSS, 1968), the number of the pits are 2-3 (Plate 6.2., fig. 4).

Remark. - This tissue structure is very similar to or more or less identical with the *Glyptostroboxylon tenerum* CONVENTZ published by HARASZTY (1957) from Hidas (Mecsek, Miocene) and HARASZTY (1960) from Rudabánya. The preservation of the cross-sectional picture is similar to those published by SÁRKÁNY (1943), (Plate XLVII, figs. 7-9), from the Miocene lignites of Várpalota.

Sample No. 3: *Taxodioxylon distichoides* HUARD 1966 (Plate 6.3., figs. 1-4)

The preservation of this sample is peculiar. The greatest part of the woody remnant was in a bad preservation, but in some small parts the most important characteristic features are well preserved. The horizontal wall of the longitudinal parenchym cells are thickened. There are resin drops in these cells (Plate 6.3., fig. 1). The observed rays are of 2-8 cells high (Plate 6.3., fig. 2). The wall of the tracheids following HUARD (1966); p. 19: "ne possèdent pas d'épaississements spiralés vrais, mais la plupart ont un aspect strié en hélice provoqué par la dissociation des fibrilles de cellulose de la paroi secondaire."

The bordered pits of the radial wall of the tracheids are in general uniseriate.

(Plate 6.3., fig. 4). In the cross fields two taxodioid pits were observed (Plate 6.3., fig. 3).

Sample No. 4: *Taxodioxylon taxodii* GOTHAN 1905 (Plate 6.4., figs. 1-4)

A relatively well preserved sample was investigated. The annual ring boundary is definite. The late wood is broad (Plate 6.4., fig. 1). The uniseriate rays are relatively 2-18 cells high (Plate 6.4., fig. 2). There are dark resin drops in the longitudinal parenchym cells (Plate 6.4., fig. 3). The horizontal wall of the longitudinal parenchym cell is thickened. The number of the thickenings is about 4-5. The number of the tiny pits in the cross fields are 2-3. This number is in several cases not well perceptible in consequence of the preservation state (Plate 6.4., fig. 4).

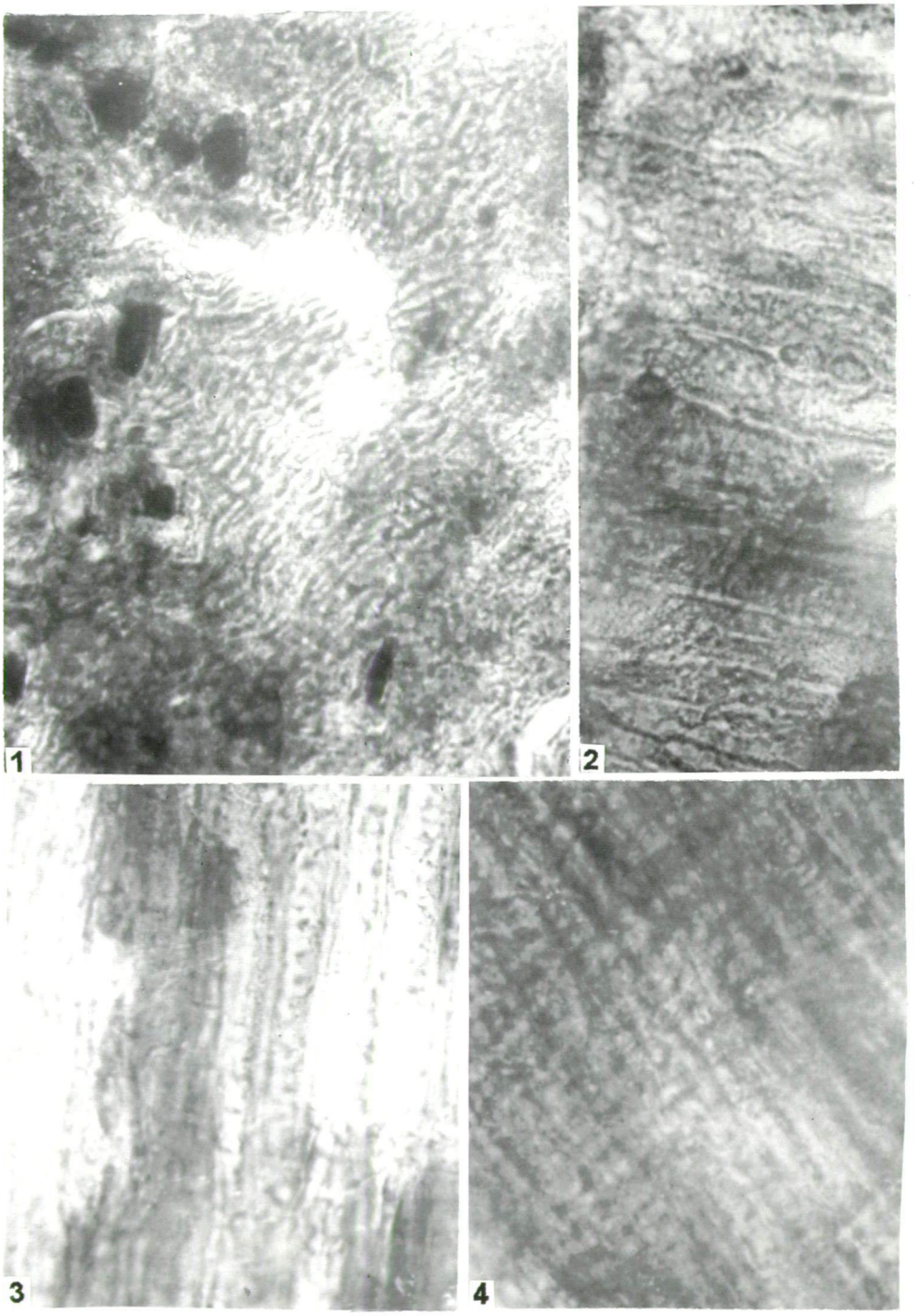
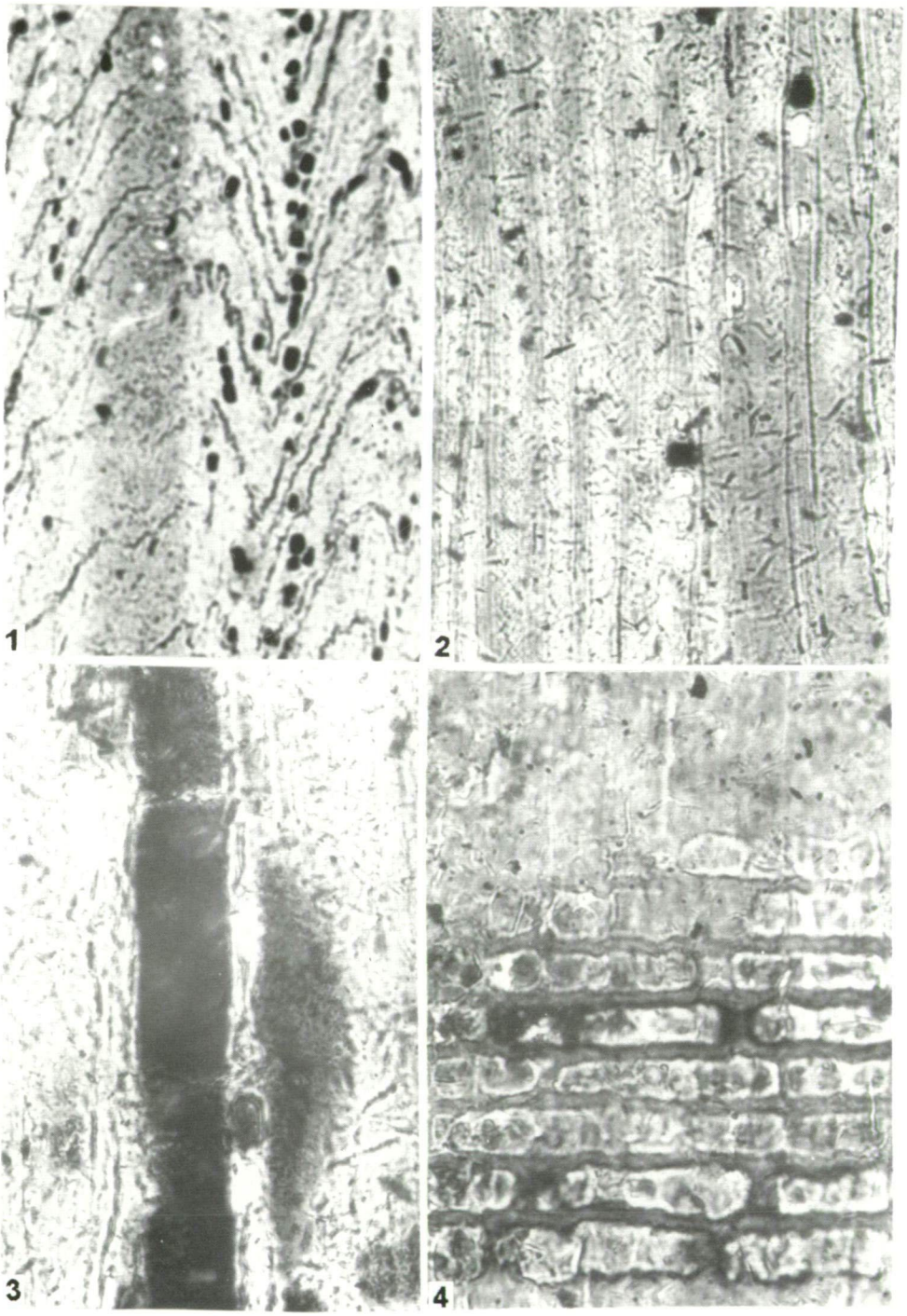


Plate 6.1.



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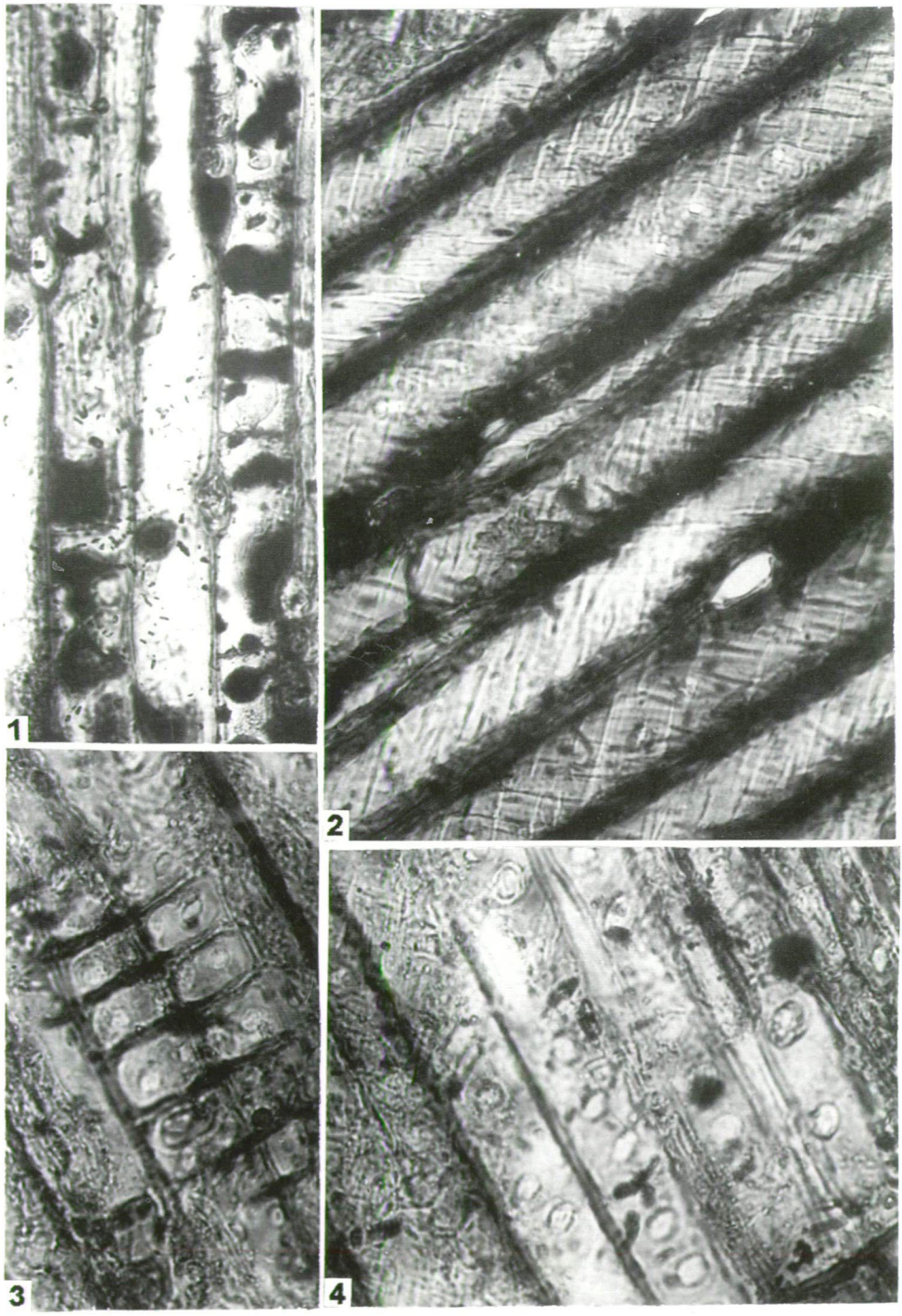


Plate 6.3.

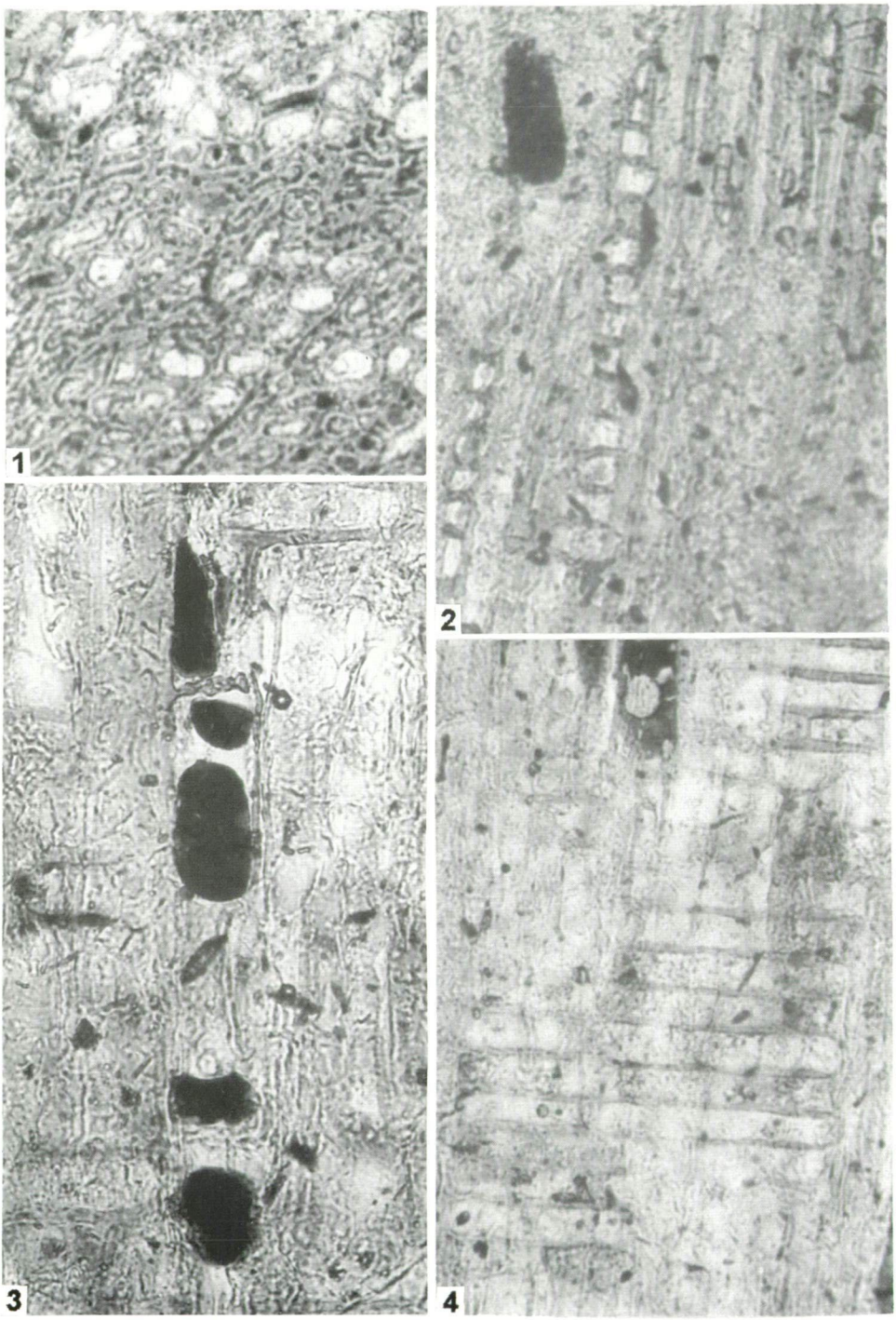


Plate 6.4.

Sample No. 5: *Cupressinoxylon secretiferum* GREGUSS 1967 (Plate 6.5., figs. 1-5)

The annual rings are distinct, the late wood is broad (Plate 6.5., fig. 1). Striations on the wall of the tracheids are not in a good preservation (Plate 6.5., fig. 2). The longitudinal parenchym and the cells of the rays are full of dark resinous content (Plate 6.5., figs. 2-5). The rays are uniseriate and in general 1-4-8 cells high (Plate 6.5., figs. 2,4). The horizontal wall of the longitudinal parenchym cell is generally not thickened (Plate 6.5., fig. 3). The areolate pits of the radial wall of the tracheids are uniseriate, but in several places not well perceptible. In the cross fields there are in general one or two cupressoid pits (Plate 6.5., fig. 5).

Sample No. 6: *Cupressinoxylon* cf. *secretiferum* GREGUSS 1967 (Plate 6.6., figs. 1-4)

The preservation state of this sample is extremely interesting. The greatest part is amorphous lignite, there are uniseriate thick walled tracheids "embedded" in this homogeneous substance (Plate 6.6., fig. 1). The uniseriate ray cells are not always filled with dark resinous content probably in consequence of the fossilization process (Plate 6.6., figs. 2,3). In our thin slides the cupressoid pittings of the cross fields are relatively well preserved, their number is 1-3 (Plate 6.6., fig. 4).

Plate 6.1.

1-4. Cf. *Taxodiaceae*
1. Cross section, 500x.
2. Tangential section, 500x.
3. Radial section, bordered pits of the tracheids, 500x.
4. Radial section, cross fields, 500x.

Plate 6.2.

1-4. *Glyptostroboxylon* sp.
1. Cross section, 250x.
2. Tangential section, 500x.
3. Tangential section, 750x.
4. Radial section, cross fields, 750x.

Plate 6.3.

1-4. *Taxodioxylon distichoides* HUARD 1966
1. Tangential section, 500x.
2. Tangential section, 750x.
3. Radial section, cross fields, 750x.
4. Radial section, areolate pitting on the radial wall of the tracheids, 750x.

Plate 6.4.

1-4. *Taxodioxylon taxodii* GOTHAN 1905
1. Cross section, 500x.
2. Tangential section, 500x.
3. Tangential section, 750x.
4. Radial section, cross fields, 500x.

3. Tissue fragments within the spore-pollen assemblage

The tissue fragments observed in the slides for palynological studies are in different state of preservation. Dark nearly black fragments and light brownish tissue occurred in the same samples. The greatest part of the observed secondary xylem remnants is of *gymnospermous* origin. The bordered pits of the radial wall of the tracheids (Plate 6.7., figs. 1,3,4,5) may be of *Taxodiaceae* origin. Based on the book of GREGUSS (1967) similar pitting was described from the following genuses: *Cupressinoxylon, Sequoioxylon, Metasequoioxylon, Glyptostroboxylon* and *Taxodioxylon*. In picture 1 of Plate 6.7., a very coalified tissue fragment is illustrated, the other one is not so carbonified. The cross field pitting illustrated in fig. 2 (Plate 6.7.) is very similar to the well preserved *Sequoioxylon gypsaceum* (GOEPPERT) GREGUSS 1967 from the Helvetian of Sajószentpéter (Plate LXIV, figs. 7-9, in the book of GREGUSS, 1967). Regarding the recent taxa this is comparable with *Sequoia sempervirens* (LAMBERT) ENDL. (GREGUSS, 1955, Plate 189, fig. 3). Similar but poorly preserved cross field is illustrated in fig. 6 (Plate 6.7.). Radial pitting of the autumn tracheids is illustrated in picture 7 (Plate 6.7.). This also may be of *Taxodiaceae* origin, but very similar structure was published by GREGUSS (1967) from *Cupressinoxylon secretiferum* GREGUSS 1967 in Plate LI., figs. 8,9. A poorly preserved vessel of *angiospermous* origin was observed (Plate 6.7., fig. 8). The perforation of the trachea is unknown in this way the nearer taxonomic position is only a *dicotyledonous* woody fragment. GREGUSS (1969) in his monograph on the Hungarian Tertiary *angiosperm* woods published in several fossil taxa the observed pitting of trachea.

4. Palynological data

PHYLUM: PTERIDOPHYTA
CLASSIS: PTEROPSIDA
SUBCLASSIS: LEPTOSPORANGIATAE

Ordo: *Osmundales*

Familia: *Osmundaceae, Osmunda; Baculatisporites nanus* (WOLFF 1934) KRUTZSCH 1959 subfsp. nanus (Plate 6.8., figs. 1,2).

PHYLUM: GYMNOSPERMATOPHYTA
SUBPHYLUM: PTERIDOSPERMOPHYTINA
CLASSIS: CYCADOPSIDA

Ordo: *Cycadales*

Familia: *Cycadaceae* v. *Spadiciflorae*; *Cycadopites minor* (KEDVES 1961) KEDVES 1968 (Plate 6.8., fig. 12).

SUBPHYLUM: CONIFEROPHYTINA
CLASSIS: CONIFEROPSIDA

Ordo: *Pinales*

Familia: *Abietaceae, Pinus; Pityosporites peuceformis* (ZAKLINSKAYA 1957) KRUTZSCH 1971 (Plate 6.8., fig. 3), *Pityosporites minutus* (ZAKLINSKAYA 1957) KRUTZSCH 1971 (Plate 6.8., figs. 4,5), *Pityosporites microalatus* (POTONIÉ 1931b) THOMSON et PFLUG 1953 (Plate 6.8., fig. 6), *Cedrus; Abiespollenites cedroides* (THOMSON 1953) KRUTZSCH 1971 (Plate 6.8., fig. 7), *Keteleeria* v. *Abies; Abiespollenites dubius* (KHLONOVA 1960) KRUTZSCH 1971 (Plate 6.8., figs. 8,9), *Tsuga; Zonalapollenites helenensis* KRUTZSCH 1971 (Plate 6.8., fig. 10), cf. *Zonalapollenites azonalis* KRUTZSCH 1971 (Plate 6.8., fig. 11).

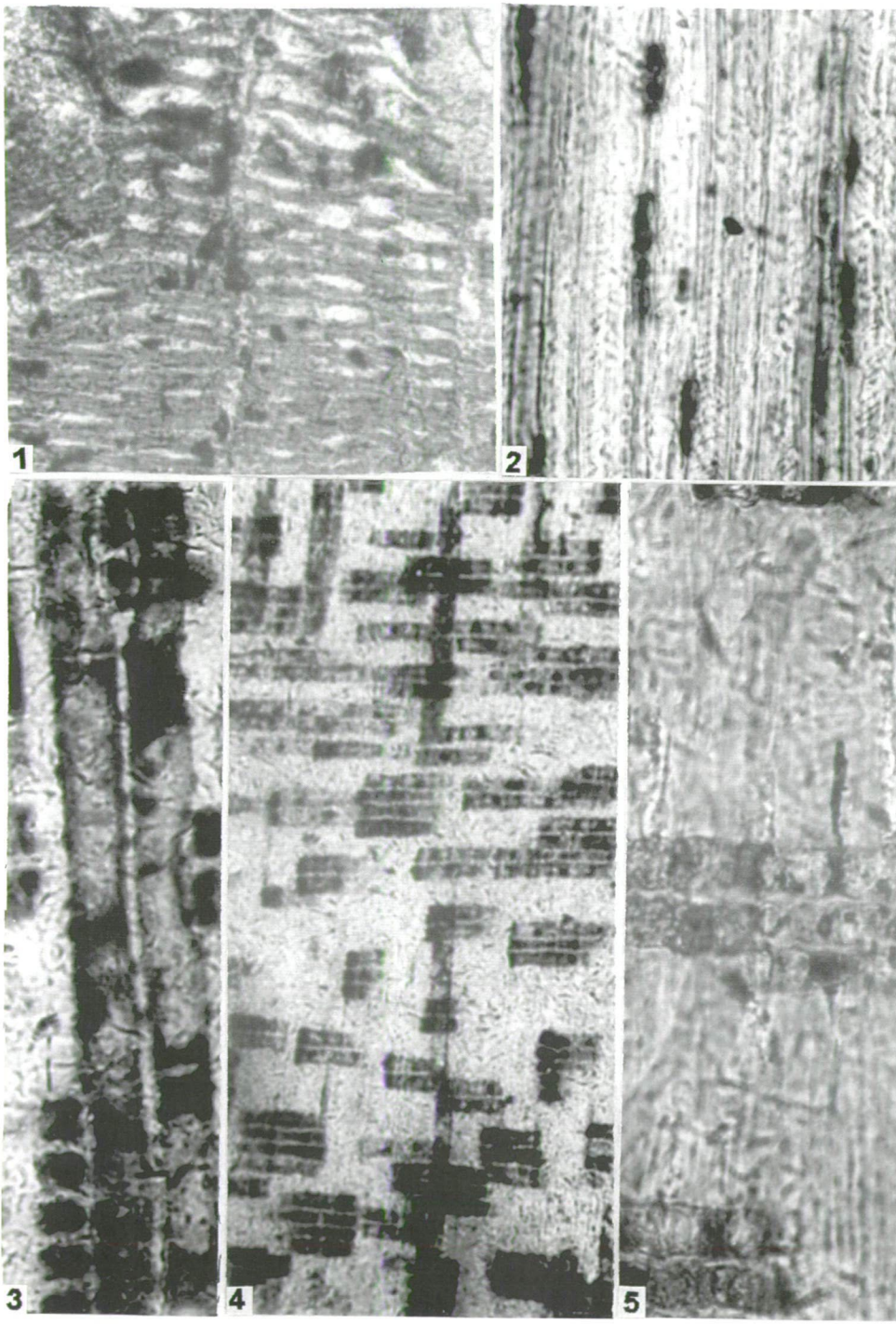


Plate 6.5.

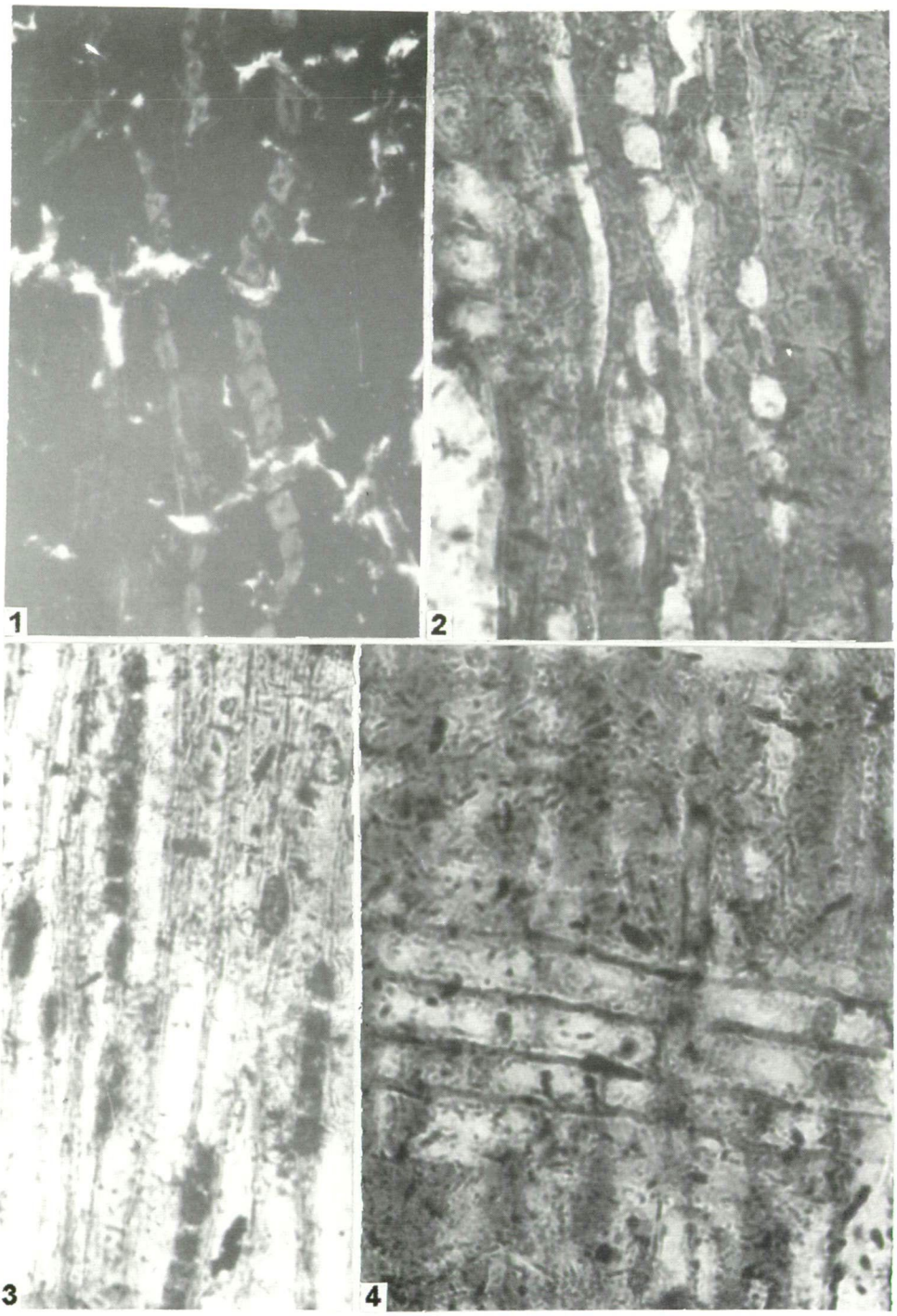


Plate 6.6.

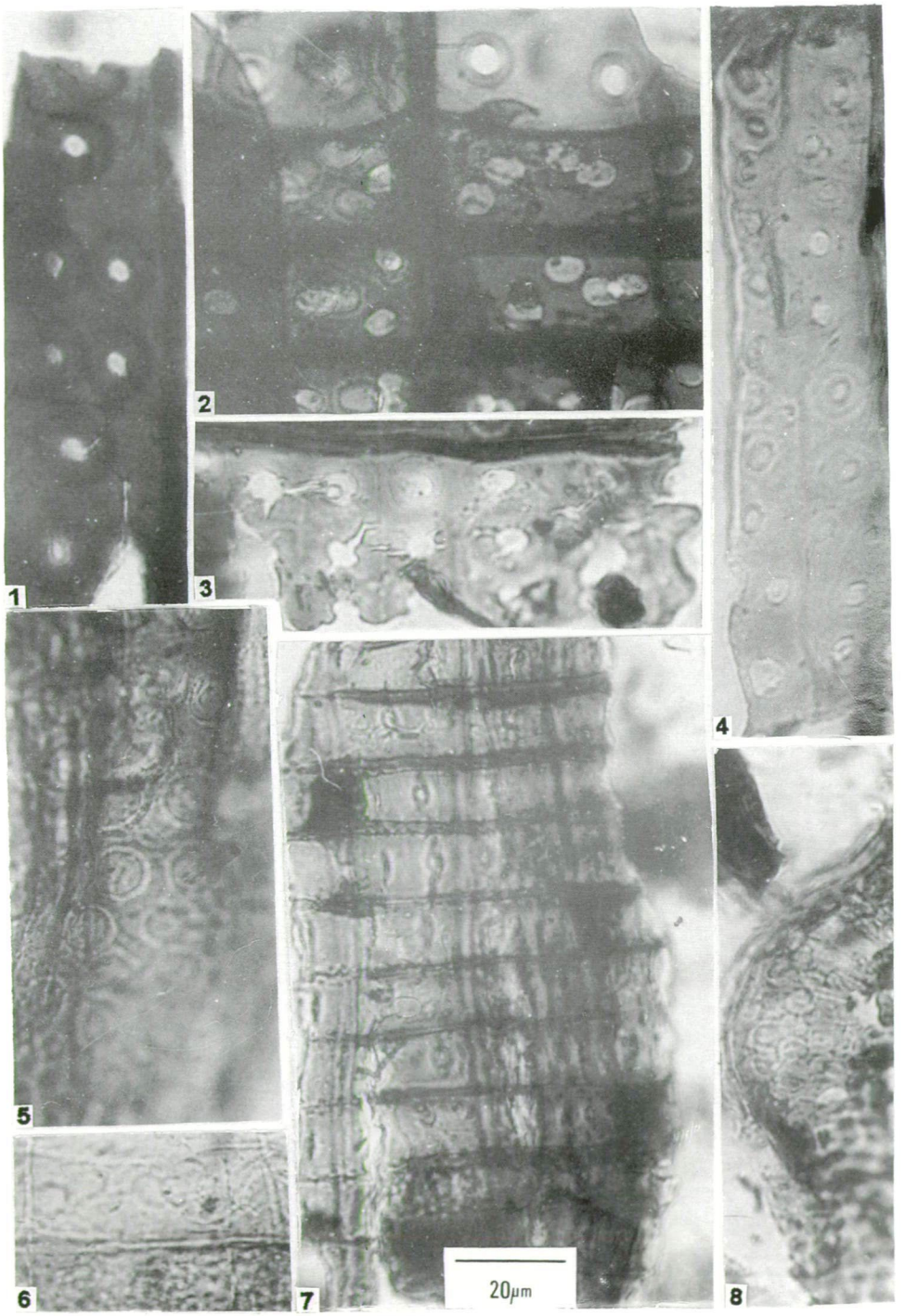


Plate 6.7.

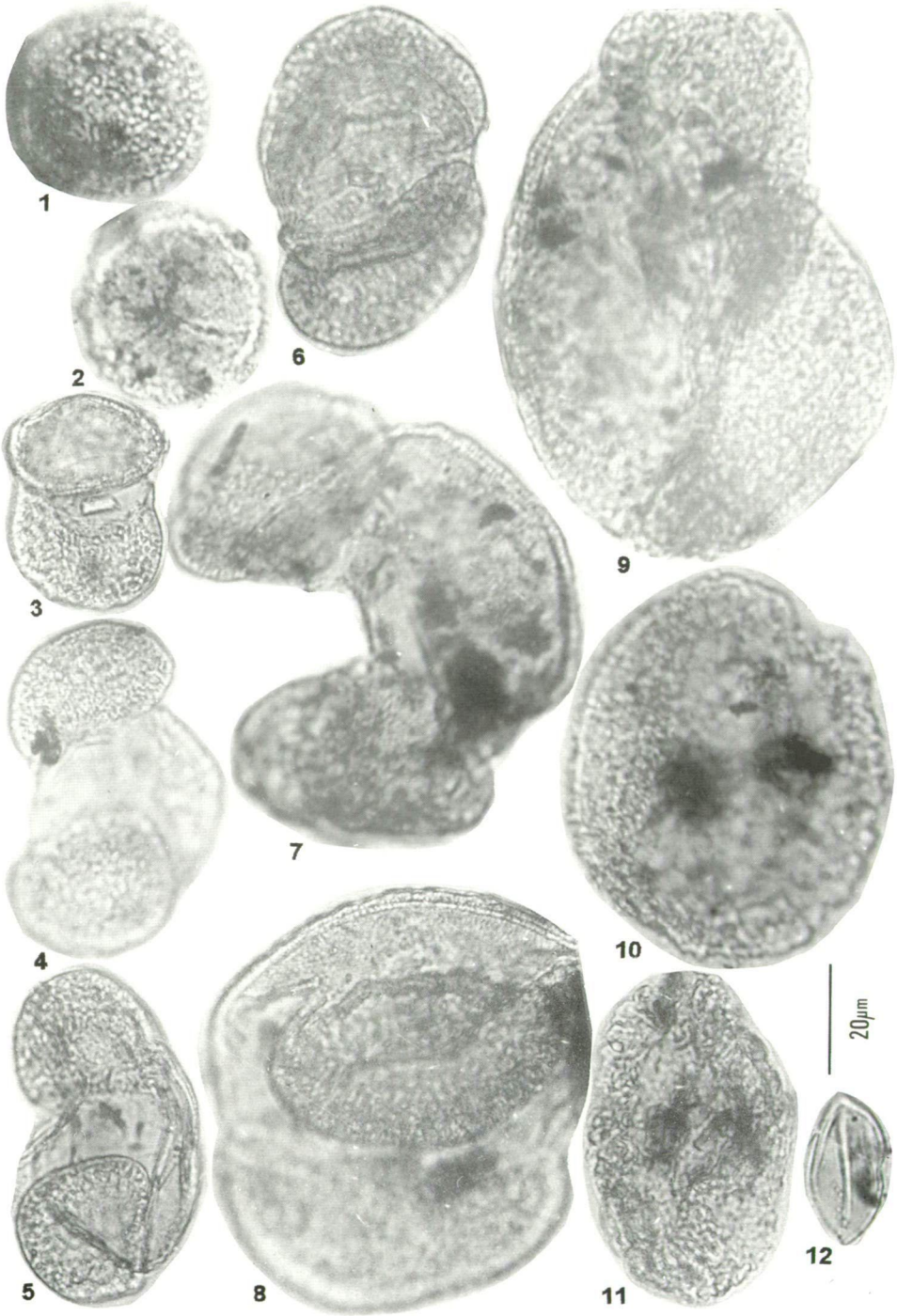


Plate 6.8.

Plate 6.5.

1-5. *Cupressinoxylon secretiferum* GREGUSS 1967
1. Cross section, 500x.
2. Tangential section, 500x.
3. Tangential section, 750x.
4. Radial section, 250x.
5. Radial section, 750x.

Plate 6.6.

1-4. *Cupressinoxylon* cf. *secretiferum* GREGUSS 1967
1. Cross section, 500x.
2,3. Tangential section, 500x.
4. Radial section, 500x.

Plate 6.7.

1. *Gymnosperm* tracheid fragment with areolate pits. Slide: GS-1-5, cross-table number: 8.0/143.9.
2. Bordered and cross field pits of probably *Sequoioxylon gypsaceum* (GOEPPERT) GREGUSS 1967 origin. Slide: GS-1-5, cross-table number: 17.3/138.9.
3-5. Fragment of *gymnosperm* tracheid with areolate pits.
3. Slide: GS-1-6, cross-table number: 9.3/142.8.
4. Slide: GS-1, cross-table number: 15.4/138.1.
5. Slide: GS-1, cross-table number: 20.4/138.4.
6,7. Cross field pits.
6. Slide: GS-1-7, cross-table number: 14.6/130.4.
7. Slide: GS-1-6, cross-table number: 22.2/145.8.
8. *Angiosperm* vessel fragment. Slide: GS-1-7, cross-table number: 23.1/140.8.

Plate 6.8.

1. *Baculatisporites nanus* (WOLFF 1934) KRUTZSCH 1959 subfsp. *nanus*, *Osmundaceae*, *Osmunda*, slide: GS-1-7, cross-table number: 19.4/139.9.
2. *Baculatisporites nanus* (WOLFF 1934) KRUTZSCH 1959 subfsp. *nanus*, *Osmundaceae*, slide: GS-1-7, cross-table number: 18.6/129.3.
3. *Pityosporites peuceformis* (ZAKLINSKAYA 1957) KRUTZSCH 1971, *Abietaceae*, *Pinus*, slide: GS-3, cross-table number: 9.4/138.2.
4. *Pityosporites minutus* (ZAKLINSKAYA 1957) KRUTZSCH 1971, *Abietaceae*, *Pinus*, slide: GS-4, cross-table number: 23.3/138.4.
5. *Pityosporites minutus* (ZAKLINSKAYA 1957) KRUTZSCH 1971, *Abietaceae*, *Pinus*, slide: GS-1, cross-table number: 15.4/138.9.
6. *Pityosporites microalatus* (POTONIÉ 1931b) THOMSON et PFLUG 1953, *Abietaceae*, *Pinus*, slide: GS-3, cross-table number: 18.1/129.9.
7. *Abiespollenites cedroides* (THOMSON 1953) KRUTZSCH 1971, *Abietaceae*, *Cedrus*, slide: GS-4, cross-table number: 18.6/143.7.
8. *Abiespollenites dubius* (KHLONOVA 1960) KRUTZSCH 1971, *Abietaceae*, *Keteleeria* v. *Abies*, slide: GS-3, cross-table number: 13.6/134.8.
9. *Abiespollenites dubius* (KHLONOVA 1960) KRUTZSCH 1971, *Abietaceae*, *Keteleeria* v. *Abies*, slide: GS-4, cross-table number: 14.2/137.4.
10. *Zonalapollenites helenensis* KRUTZSCH 1971, *Abietaceae*, *Tsuga*, slide: GS-1, cross-table number: 14.3/143.2.
11. *Cf. Zonalapollenites azonalis* KRUTZSCH 1971, *Abietaceae*, *Tsuga*, slide: GS-1, cross-table number: 26.6/137.2.
12. *Cycadopites minor* (KEDVES 1961) KEDVES 1968, *Cycadaceae* v. *Spadiciflorae*, slide: GS-1-7, cross-table number: 10.6/129.7.

PHYLUM: ANGIOSPERMATOPHYTA
CLASSIS: DICOTYLEDONOPSIDA

Ordo: *Myrtales*
Familia: *Elaeagnaceae; Elaeagnacites huanghuaensis* KE et SHI 1978 (Plate 6.9., fig. 11).

Ordo: *Campanulales*
Familia: *Lobeliaceae; Lobeliapollenites erdtmani* E. NAGY 1969 (Plate 6.9., fig. 3).

Ordo: *Urticales*
Familia: *Ulmaceae, Celtidoideae, Zelkova; Zelkovaepollenites thiergarti* E. NAGY 1969, (Plate 6.9., fig. 8), *Celtis; Celtipollenites komloensis* E. NAGY 1969 (Plate 6.9., fig. 10).

Ordo: *Fagales*
Familia: *Betulaceae, Alnus; Alnipollenites verus* POTONIÉ 1934 (Plate 6.9., fig. 7), *Ostrya; Ostryapollenites rhenanus* (THOMSON 1950), E. NAGY 1969 (Plate 6.9., fig. 6).
Familia: *Fagaceae, Quercus; Quercopollenites granulatus* E. NAGY 1969 (Plate 6.9., fig. 2), *Quercopollenites* fsp. *petraea* type (Plate 6.9., fig. 5), cf. *Castanea; Cupuliferoipollenites oviformis* (POTONIÉ 1931a) POTONIÉ 1960 (Plate 6.9., fig. 4).
Fagaceae v. *Leguminosae; Cupuliferoidaepollenites quisqualis* (POTONIÉ 1934) POTONIÉ 1960 (Plate 6.9., fig. 1).

CLASSIS: MONOCOTYLEDONOPSIDA

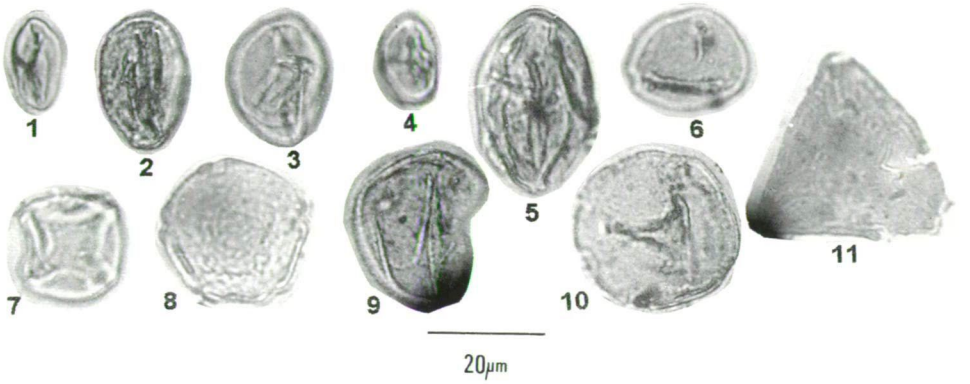
Ordo: *Pandanales*
Familia: *Sparganiaceae; Sparganiaceaepollenites polygonalis* THIERGART 1938 (Plate 6.9., fig. 9).

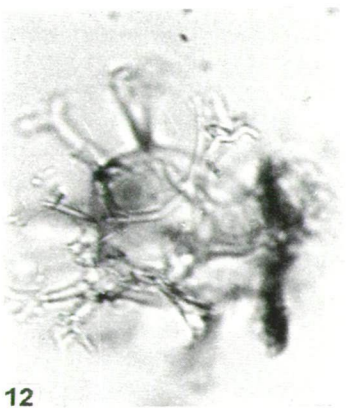
Microplancton remnants

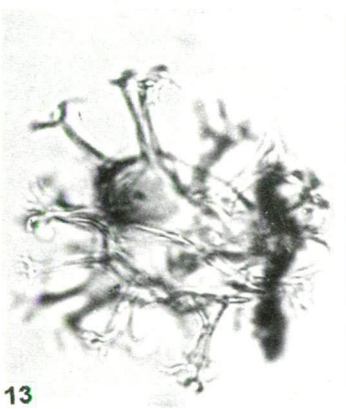
The observed organic microplancton remnants are reworked from older sediments.

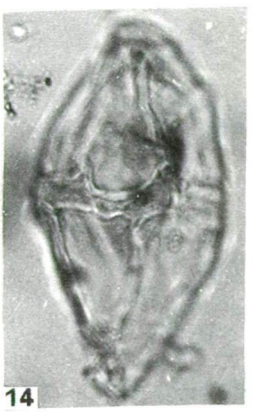
Jurassic reworked taxa: Cf. *Acanthaulax* sp.$_1$ (Plate 6.9., figs. 15,16), cf. *Acanthaulax* sp.$_2$ (Plate 6.9., fig. 17, plate 6.10., fig. 1), *Leptodinium ambiguum* (DEFLANDRE 1939) HELENES 1984 (Plate 6.10., figs. 2,3), *Occisucysta balia* GITMEZ 1970 (Plate 6.10., figs. 4,5), *Neuffenia willei* BRENNER et DÜRR 1986 (Plate 6.10., fig. 6).

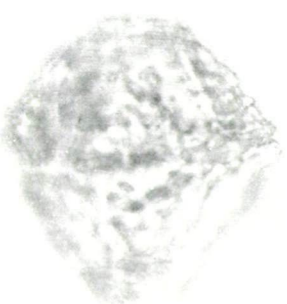
Cretaceous reworked taxa: *Hystrichosphaera ramosa* (EHRENBERG 1838) O. WETZEL 1933 var. ramosa DAVEY et WILLIAMS 1966 (Plate 6.9., figs. 12,13), *Dinogynium* sp. (Plate 6.9., fig. 14).

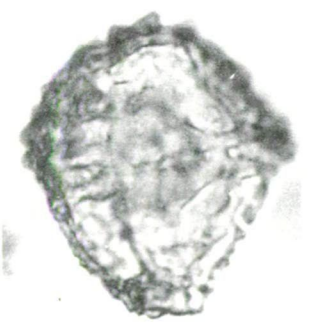












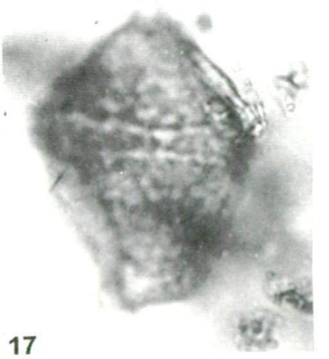


Plate 6.9.

Quantitative data

The per cent of the invesigated organic microfossils may be summarized as follows:

Spores	0.8%
Gymnospermatophyta	85.8%
Angiospermatophyta	7.7%
Organic-walled *Dinoflagellatae*	5.7%

The quantity of the inaperturate *gymnosperm* pollen grains (*Taxodiaceae-Cupressaceae*) is only 5.7%, the greatest part of the pollen grains is of saccate form (*Pinus, haploxylon* and *diploxylon* type, *Picea, Abies, Keteleeria, Cedrus*). So our data concerning the paleoenvironmental conditions are identical with the previous establishments. The woody remnants were deposited in the Pannonian lake in the region of Bátaszék. To the zonation of the vegetation of the shore of the sedimentary basin we have few data. Outside from the *Taxodiaceae-Cupressaceae*, the relatively high number of the pollen grains of the genus *Celtis* may be mentioned.

Discussion and Conclusions

1. The wood anatomical investigations resulted in several new data in contrast to the previous establishments. The relative taxonomic richness, and the peculiar preservations indicate the allochtonous origin of these samples. The reworked planctonic remnants support this assumption.

Plate 6.9.

1. *Cupuliferoidaepollenites quisqualis* (POTONIÉ 1934) POTONIÉ 1960, *Fagaceae* v. *Leguminosae*, slide: GS-1-6, cross-table number: 7.3/145.2.
2. *Quercopollenites granulatus* E. NAGY 1969, *Fagaceae, Quercus*, slide: GS-3, cross-table number: 11.0/128.0.
3. *Lobeliapollenites erdtmani* E. NAGY 1969, *Campanulales, Lobeliaceae*, slide: GS-1, cross-table number: 14.2/149.6.
4. *Cupuliferoipollenites oviformis* (POTONIÉ 1931a) POTONIÉ 1960, *Fagaceae, Castanea*, slide: GS-1-6, cross-table number: 9.8/130.7.
5. *Quercopollenites* fsp., *petraea* type, slide: GS-3, cross-table number: 22.9/134.8.
6. *Ostryapollenites rhenanus* (THOMSON 1950) E. NAGY 1969, *Fagaceae, Ostrya*, slide: GS-1-6, cross-table number: 10.2/130.7.
7. *Alnipollenites verus* POTONIÉ 1934, *Betulaceae, Alnus*, slide: GS-4, cross-table number: 25.6/133.8.
8. *Zelkovaepollenites thiergarti* E. NAGY 1969, *Ulmaceae, Zelkova*, slide: GS-1, cross-table number: 22.7/141.6.
9. *Sparganiaceaepollenites polygonalis* THIERGART 1938, *Sparganiaceae*, slide: GS-1-6, cross-table number: 22.6/134.2.
10. *Celtipollenites komloensis* E. NAGY 1969, *Ulmaceae, Celtidoidae*, slide: GS-1, cross-table number: 18.4/134.2.
11. *Elaeagnacites huanghuaensis* KE et SHI 1978, *Elaeagnaceae*, slide: GS-2, cross-table number: 24.5/122.2.

12,13. *Hystrichosphaera ramosa* (EHRENBERG 1838) O. WETZEL var. *ramosa* DAVEY et WILLIAMS 1966, slide: GS-4, cross-table number: 13.9/133.8.

14. *Dinogynium* sp., slide: GS-3, cross-table number: 19.8/140.9.

15,16. Cf. *Acanthaulax* $sp._1$, slide: GS-4, cross-table number: 20.3/141.7.

17. Cf. *Acanthaulax* $sp._2$, slide: GS-1-6, cross-table number: 9.3/144.8.

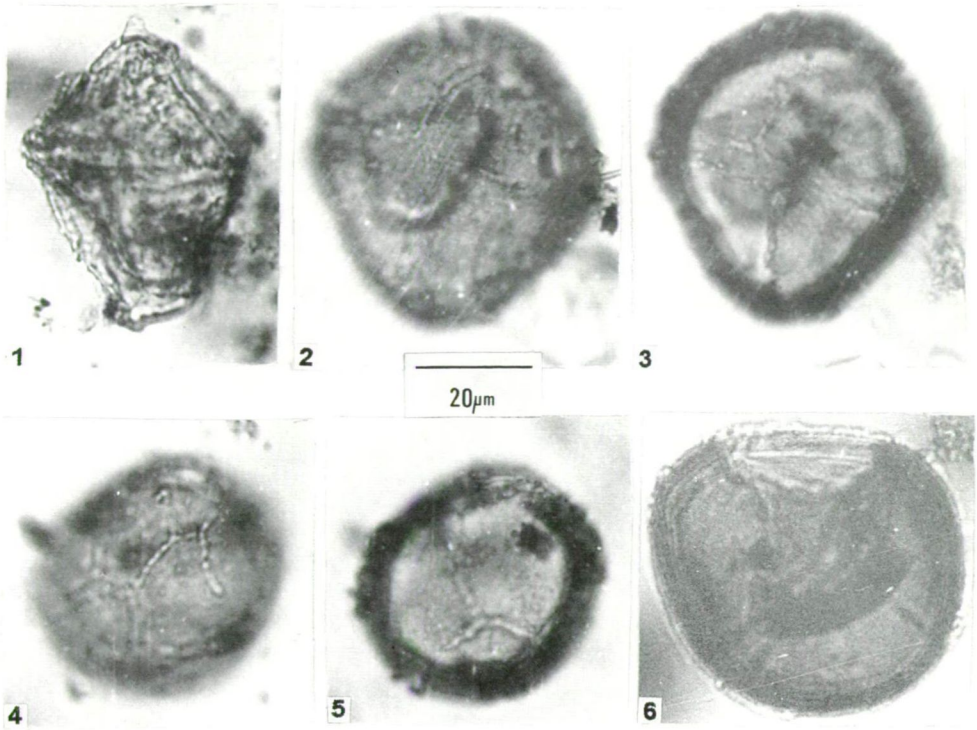


Plate 6.10.

1. Cf. *Acanthaulax* sp.$_2$, slide: GS-1-6, cross-table number: 9.3/144.8.
2,3. *Leptodinium ambiguum* (DEFLANDRE 1939) HELENES 1984, slide: GS-1-5, cross-table number: 19.8/146.2.
4,5. *Occisucysta balia* GITMEZ 1970, slide: GS-1-6, cross-table number: 24.3/128.3.
6. *Neuffenia willei* BRENNER et DÜRR 1986, slide: GS-4, cross-table number: 25.9/129.3.

2. It is worth of mentioning that reworked spores and/or pollen grains were not observed in the investigated assemblage.

3. The greatest quantity of the saccate *gymnosperm* pollen grain in the spore-pollen composition of the woody remnants embedding sediment indicate the presence of the lake during this period. The results of SHATILOVA (1999 in LENNERT et al.) are essentially identical with our observations.

Acknowledgements

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7. TRANSMISSION ELECTRON MICROSCOPY OF HUNGARIAN TERTIARY LIGNITES II.

M. KEDVES[1] and Á. PÁRDUTZ[2]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary, 2. Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, H-6701, P.O. Box 521, Szeged, Hungary

Abstract

The transmission electronmicroscopical results of three Hungarian lignite samples are presented in this contribution. Two samples of *Sequoioxylon gypsaceum* and one sample of *S. medullare* were the subject of these investigations. Non-experimental and partially dissolved lignite fragments with diethylamine and merkaptoethanol were investigated with transmission electron microscope method. The new results in comparison to the previously described ones indicate that these samples are in a very poor preservation state. Homogenisation of the secondary wall was observed, but sometimes there are important differences in the electron density of the more or less homogeneous substance.

Key words: Xylotomy, fossil, transmission electron microscopy, Tertiary, Hungary.

Introduction

During our previous investigations we established that the transmission electron microscopical method may be useful for the fossil secondary woody remnants (KEDVES and SZEDERKÉNYI, 1985). Moreover the partial dissolution with organic solvents resulted in new data for the alteration of the secondary wood during the fossilization processes (KEDVES, 1997, 1998, KEDVES and PÁRDUTZ, 1998). To continue this research program of our Laboratory in this contribution we present our new data in this respect.

The aim of this contribution was the investigation of the ultrastructure alterations for the same dissolution processes for the differentially preserved lignite samples.

Materials and Methods

The following lignite samples were the subject of our present investigations:

Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967

Sample no 3, locality: Mohács, Upper Pannonian, brickyard, lower level. LM results: KEDVES (1999), p. 39,46, plate 4.1., figs. 1-6.
(T-9-7: non-experimental material, T-9-8: dissolution with diethylamine, T-9-9: dissolution with merkaptoethanol).

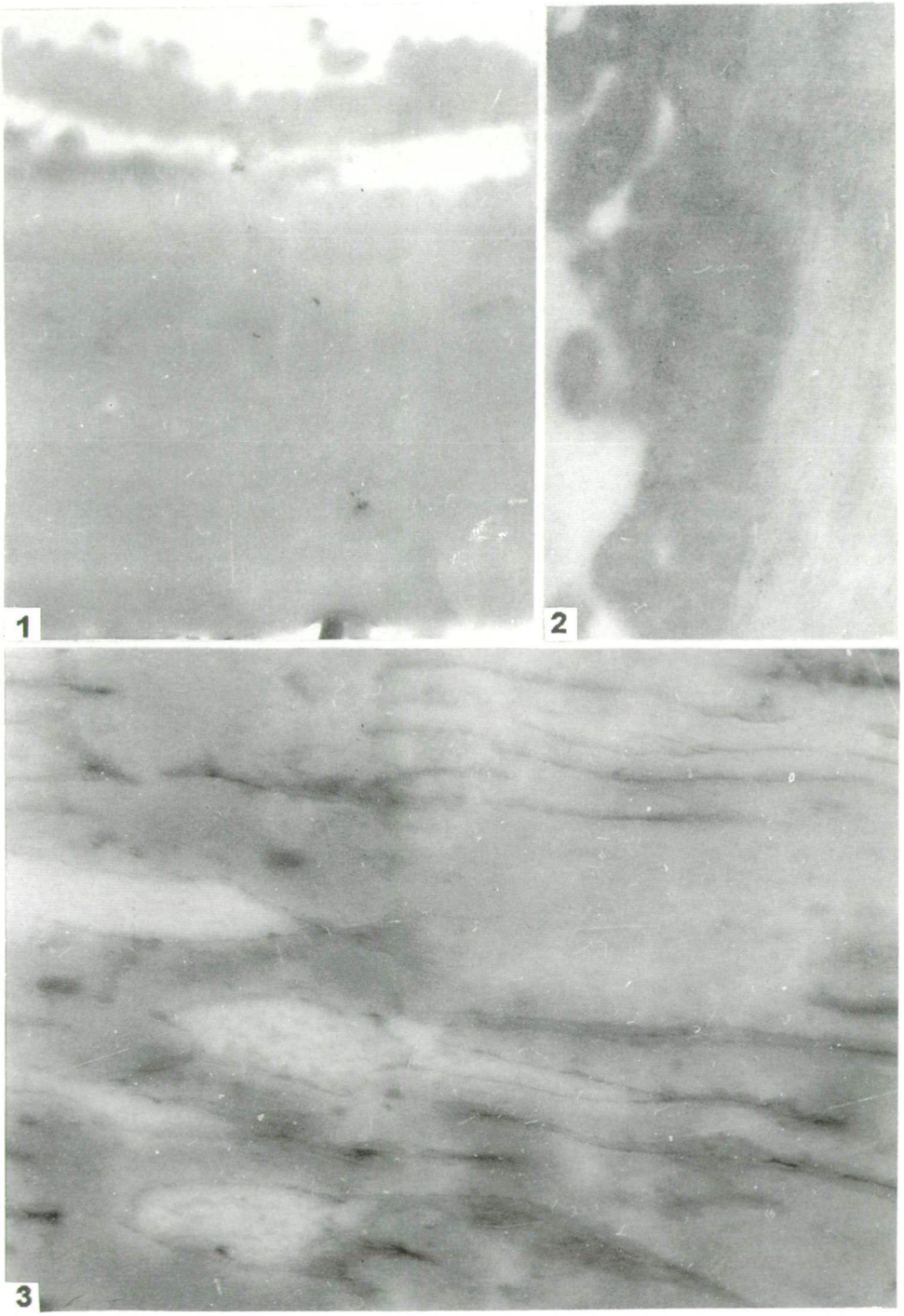

Plate 7.1.

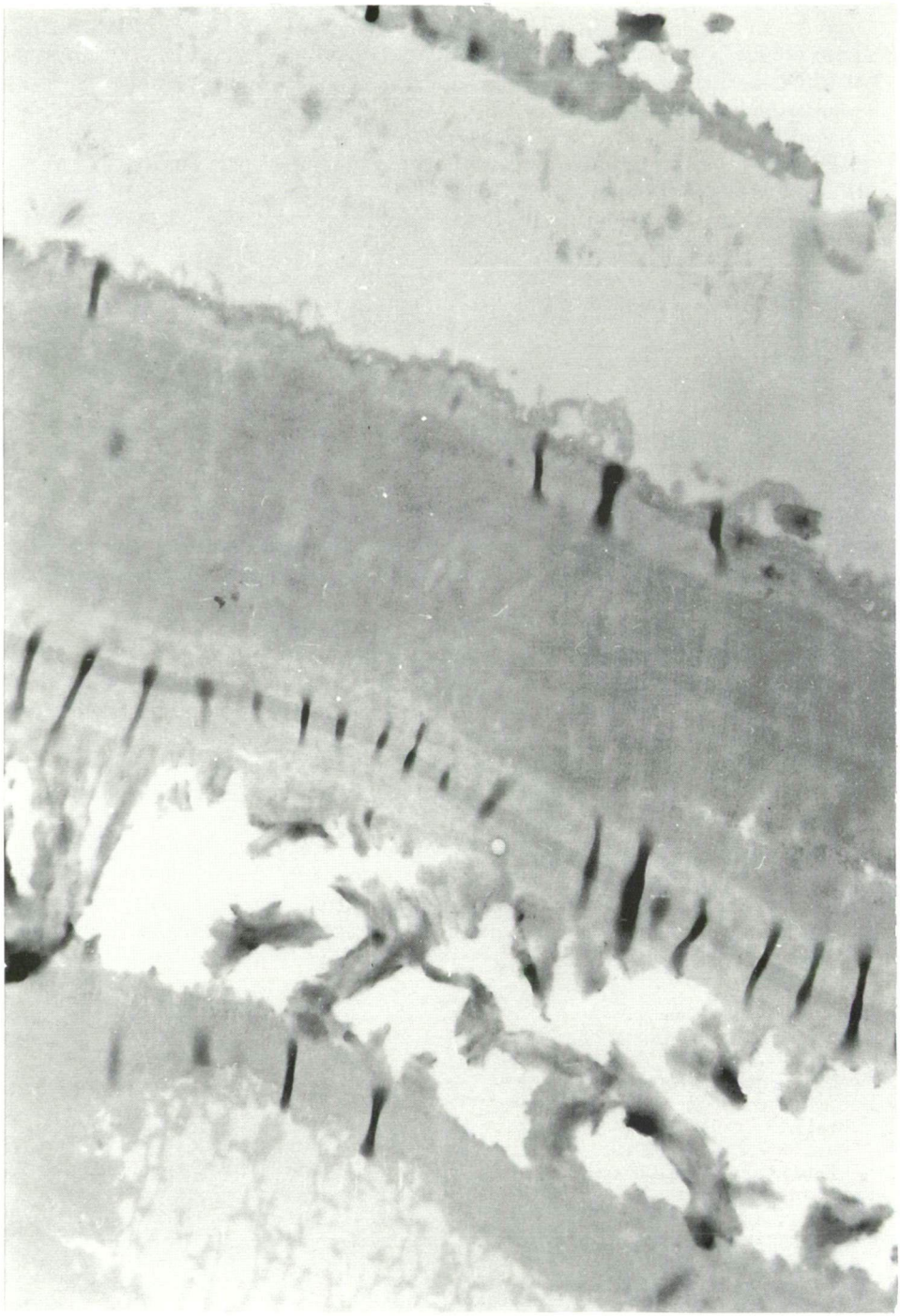

Plate 7.2.

Sample no 10, locality: Bátaszék, Upper Pannonian, layer D-1/B. LM results: KEDVES (1999), p. 46, plate 4.2., figs. 1-3.
(T-9-10: non-experimental material, T-9-11: dissolution with diethylamine, T-9-12: dissolution with merkaptoethanol).

Sample no 7, locality: Bátaszék, well no 7, depth 168.0 m., Upper Pannonian. LM results: KEDVES (1999), p. 46, plate 4.3., figs. 1-4.
(T-9-13: non-experimental material, T-9-14: dissolution with diethylamine, T-9-15: dissolution with merkaptoethanol).

The used experimental method was described in a previous paper (KEDVES 1997).

Results

Sample no: 3 (Plate 7.1., figs. 1-3, plate 7.2)
Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967

The ultrastructure of the non-experimental tracheids represents a degraded wall structure (Plate 7.1., figs. 1,2). Based on the electron density an outer and an inner part may be distinguished. The outer is more electron dense, the superficial part is irregular, (Plate 7.1., fig. 2), and some fragments or the outest part detached from the finely lamellar secondary wall (Plate 7.1., fig. 2).

Experiment T-9-8, dissolution with diethylamine during 30 days at 30 °C (Plate 7.2).

After this kind of partial dissolution the different layers of the wall fine structure of the tracheids are relatively well shown. The different layers are in all probability the following: The outest part of the secondary wall (S 3) is two layered based on the electron density. The S 2 layer is also multilamellate by its electron affinity. A relatively thin S 1 layer is probable. The primary wall and the middle lamella was extremely damaged, only some fragments were observed.

Experiment T-9-9 (Plate 7.1., fig. 3). A more or less tangential longitudinal section illustrates the extremely damaged and probably secondarily destroyed wall structure. The dark striae may represents the fossil resinous material. The light holes may be the traces of the medullary rays. No finely lamellar ultrastructure of the wall was observed at this kind of experiment.

Plate 7.1.

Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967.
1,2. Ultrastructure of the non-experimental sample (T-9-7).
1. Negative no: 6801, 10.000x.
2. Negative no: 6837, 25.000x.
3. Ultrastructure of the partially dissolved lignite sample with merkaptoethanol (T-9-9). Negative no: 6809, 25.000x.

Plate 7.2.

Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967.
Ultrastructure of the partially dissolved lignite sample with diethylamine (T-9-8). Negative no: 6839, 10.000x.

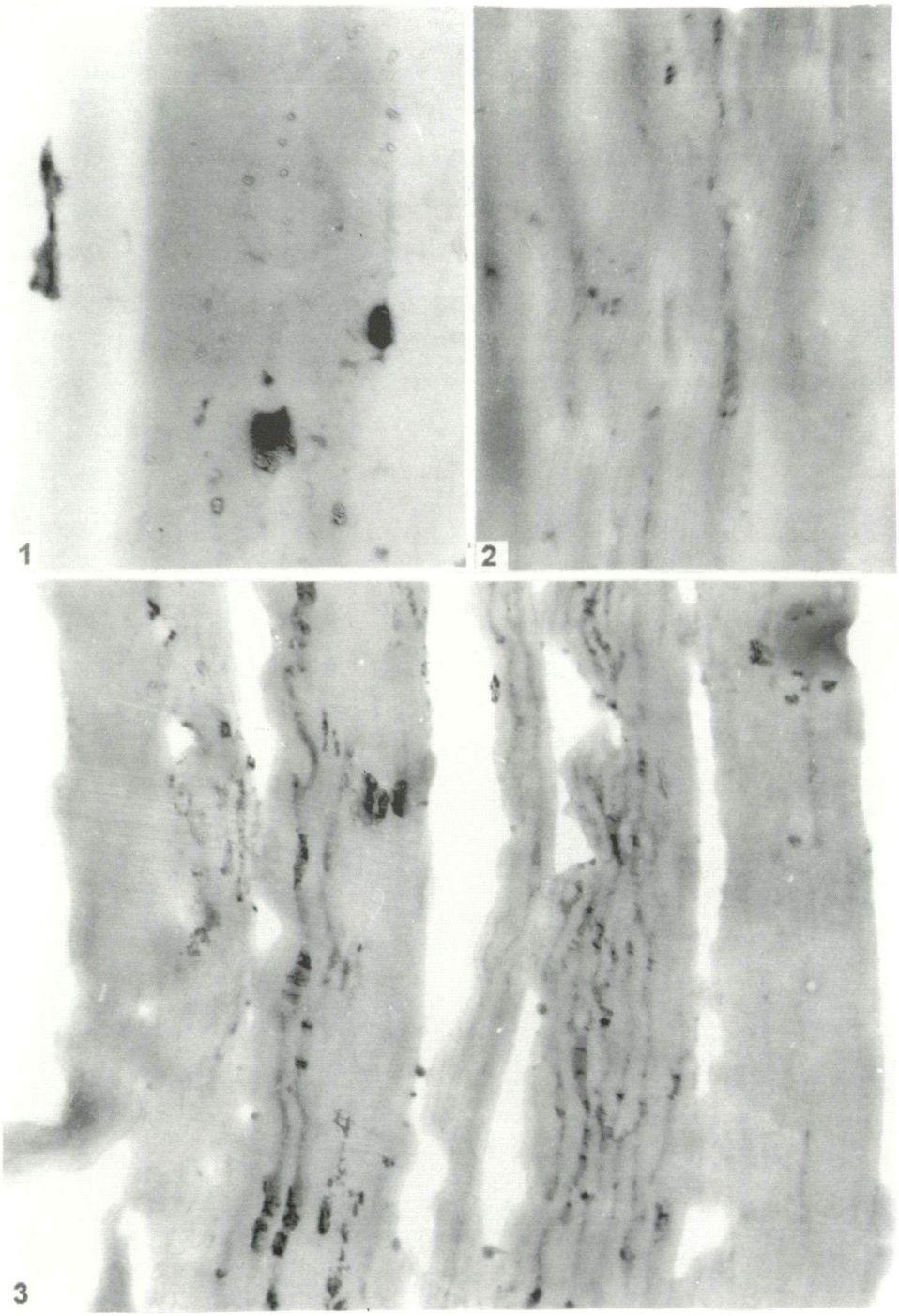

Plate 7.3.

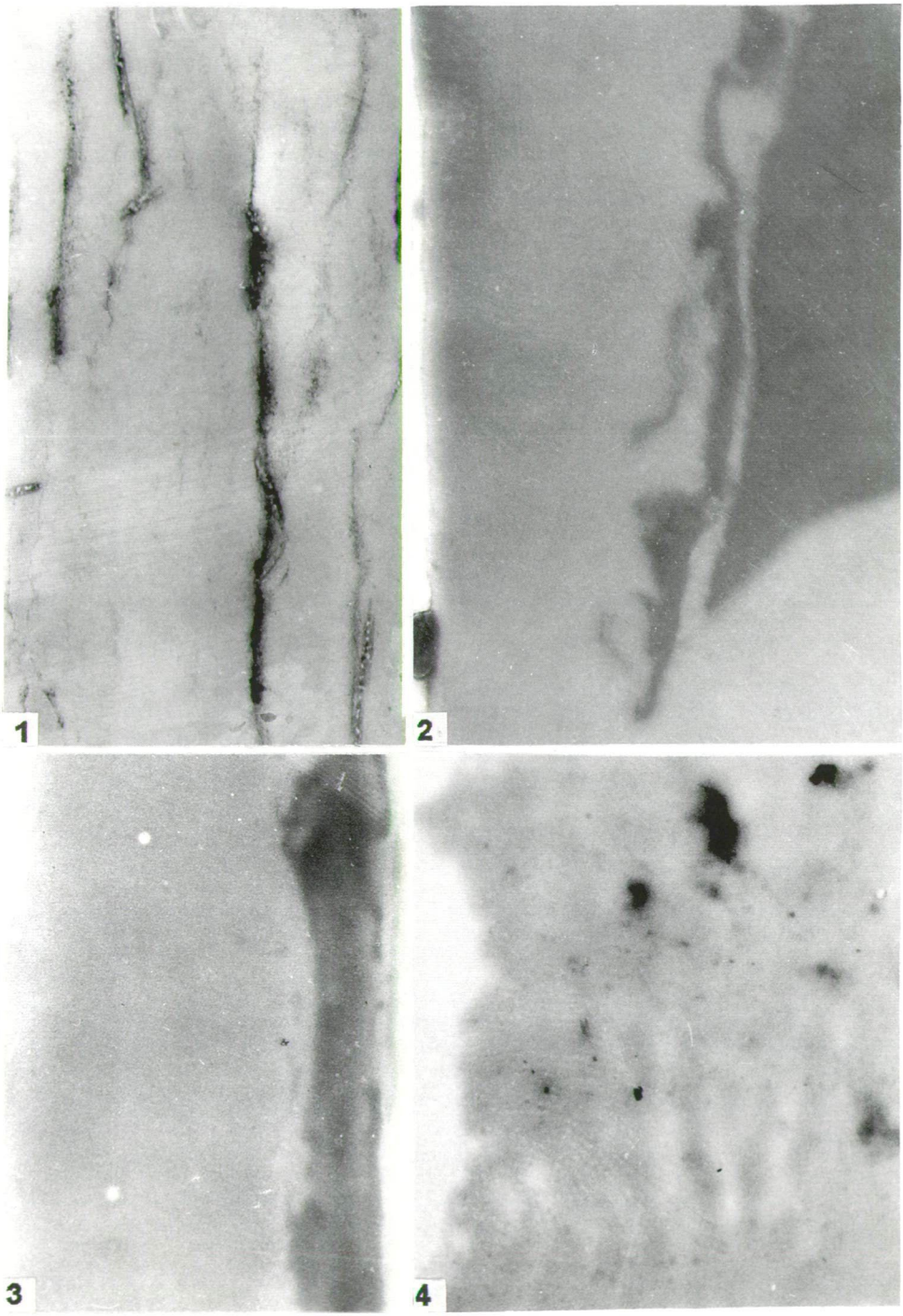

Plate 7.4.

Sample no: 10 (Plate 7.3., figs. 1-3)
Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967

As it was illustrated by the LM structure (KEDVES 1999, plate 4.2., figs. 1-3) this sample was extremely damaged and compressed during the fossilization processes, but in contrast to the previous sample the lignite material was not carbonified.

The ultrastructure of the non-experimental material (Plate 7.3., fig. 1) illustrate the extremely damaged wall structure. But within the more or less homogeneous material there are dark small particles in all probability tiny carbonified parts of the secondary wall.

Experiment: T-9-11, dissolution with diethylamine during 30 days at 30 °C (Plate 7.3., fig. 2). This probably tangential longitudinal section represents the extremely altered secondary wall ultrastructure. The darker striae may be remnants of the resinous material within the longitudinal parenchyma, and similarly to the previous by light holes the traces of the medullary rays may be presumed.

Experiment: T-9-12, dissolution with merkaptoethanol during 30 days at 30 °C (Plate 7.3., fig. 3). A longitudinal ultrathin section was investigated. The extremely degraded secondary wall structure is also well shown in this picture. But the dissolution process discovered remnants of the finely lamellar structure. There are dark carbonified particles and remnants of the resinous material within the longitudinal parenchyma in the homogeneous or very finely lamellar secondary wall.

Sample no: 7 (Plate 7.4., figs. 1-3)
Sequoioxylon medullare GREGUSS 1967

The preservation of this lignite sample based on the LM investigations (KEDVES 1999, plate 4.3., figs. 1-4) is quite good. In picture 1 in the paper of KEDVES (1999) it is well shown that in some part of the lignite sample the tracheids are carbonified. On other part of the sample strong degradation may be observed.

The TEM picture of the non-experimental lignite sample (T-9-13, Plate 7.4., fig. 1) illustrates a damaged, homogenised secondary wood fragment, with longitudinal electron dense striae. These dark striae may be the remnants of the resinous material in the longitudinal parenchyma. In some part of the more or less homogeneous lignite remnants fine lamellar structure is also present.

Plate 7.3.

Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967.
1. Ultrastructure of the non-experimental lignite sample (T-9-10). Negative no: 6817, 25.000x.
2. TEM picture of the partially dissolved lignite sample with diethylamine (T-9-11). Negative no: 6822, 25.000x.
3. Ultrastructure of the partially dissolved lignite fragment with merkaptoethanol (T-9-12). Negative no: 6833, 10.000x.

Plate 7.4.

Sequoioxylon medullare GREGUSS 1967.
1. Ultrastructure of the non-experimental lignite sample (T-9-13). Negative no: 6904, 25.000x.
2. Ultrastructure of the partially dissolved lignite fragment with diethylamine (T-9-14). Negative no: 6911, 10.000x.

3,4. Ultrastructure of the partially dissolved lignite samples with merkaptoethanol (T-9-15).
3. Negative no: 6917, 10.000x.
4. Negative no: 6919, 10.000x.

Experiment: T-9-14, dissolution with diethylamine during 30 days at 30 °C (Plate 7.4., fig. 2). The secondary wood of the lignite sample was extremely altered. Two kinds of preservation were observed a lighter completely homogeneous part and a dark, electron dense particle embedded in this substance.

Experiment: T-9-15, dissolution with merkaptoethanol during 30 days at 30 °C (Plate 7.4., figs. 3,4). The preservation of the different lignite fragments of this sample is not the same. Fig. 3 in Plate 7.4., illustrates a similar preservations of the ultrastructure as at the previous experiment. But at other part of the lamellar ultrastructure very poor preservations was observed (Plate 7.4., fig. 4). Within the lamellae sometimes there are some electron dense small granular particles.

Discussion and Conclusions

1. The two samples of *Sequoioxylon gypsaceum* are in a poor preservation in comparison to the previously investigated and published sample (KEDVES and PÁRDUTZ, 1999, Plate 5.1., 5.2., 5.3.). The lamellar structure which was observed after the dissolution with merkaptoethanol previously was not present (Plate 7.1., fig. 3) or in a very damaged preservation state (Plate 7.3., fig. 3).

2. The differences in the ultrastructure of *Sequoioxylon medullare* of the previously and presently investigated samples are also very characteristics. Recently superficial alterations of the tracheids were not observed.

Finally, based on the up-to-date knowledge its seems that the alterations in consequence of the fossilization processes the fine structure of the lignite samples may be extremely different. The homogenisation in the fine structure may be advanced, but the substance of the secondary wall may be different. Very coalified fragments may occur in the lighter homogenised substance.

Acknowledgements

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8. REDEPOSITED SPOROMORPHS FROM HOLOCENE LAKE SEDIMENTS OF CAUCASUS

E. KVAVADZE[1], M. KEDVES[2], M. MADARÁSZ[2] and A. HORVÁTH[2]

1. L.Sh. Davitashvili Institute of Palaeobotany, Georgia Academy of Sciences, Tbilisi 83, Georgia 380083; 2. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

The redeposited sporomorphs isolated from the Holocene sediments of the Samurskoe Lake are presented in this contribution. The greatest part of the secondary sporomorphs are spores with some bisaccate *gymnosperm* pollen grains. The redeposited spores are mostly of *Gleicheniaceae* type which are characteristic for the Lower and Middle Cretaceous sediments. Similar *gleicheniaceous* spores of the Lower Cretaceous were published by DÖRING from Germany, and BOLKHOVITINA from Russia.

Key words: Palynology, fossil, redeposited sporomorphs, Caucasus.

Introduction

There are a number of publications concerning the investigation of the redeposited sporomorphs (IVERSEN, 1936, M. GRICHUK, 1950, V. GRICHUK, 1950, FRIIS, 1953, ANANOVA, 1960, CUSHING, 1962, 1964, WILSON, 1964, KEDVES, ENDRÉDI and SZELEY, 1966, STANLEY, 1966, 1967, MUIR, 1967, VENKATACHALA, 1969, SCOTT and SRIVASTAVA, 1984, LIIVRAND, 1976, 1989, BATTEN, 1996). Concerning this problem KEDVES (1986) emphasized the following; p. 14: "As a result of latest progress in this field, palynology has turned out to be in many cases the only tool to establish the fact of allochtony or to determine the age of the redeposited sediments. Nowadays the method itself is applied to several purposes: 1. Classical method based on a wide, comprehensive knowledge of the sporomorphs characteristic of the different geological ages. 2. Separation of allochtonous sporomorphs by colouring techniques. 3. Use of fluorescence microscopy."

The redeposited sporomorphs of the recent and Holocene sediments of the Caucasus Mountains were discussed in previous papers, by KVAVADZE (1984, 1991, 1996), KVAVADZE and EFREMOV (1998a,b).

The aim of our paper is to investigate the redeposited spores and pollen grains from the Samurskoe Lake, and compare the secondary sporomorphs with the Lower and Middle Cretaceous assemblages of other regions of the Northern Hemisphere.

Materials and Methods

The sediments were prepared in the Laboratory of Tbilisi, and three samples with organic material were sent to the Cell Biological and Evolutionary Micropaleontological

Laboratory of the J.A. University in Szeged. The LM investigation of the sedimentary autochton sporomorphs were investigated by Dr. E. KVAVADZE in Tbilisi, the redeposited forms by Dr. M. KEDVES and his co-workers in Szeged. The LM pictures of the secondary forms were taken in the C.B.E.M. Laboratory of the Dept. of Botany of the J.A. University in Szeged. All the pictures are unretouched.

Results

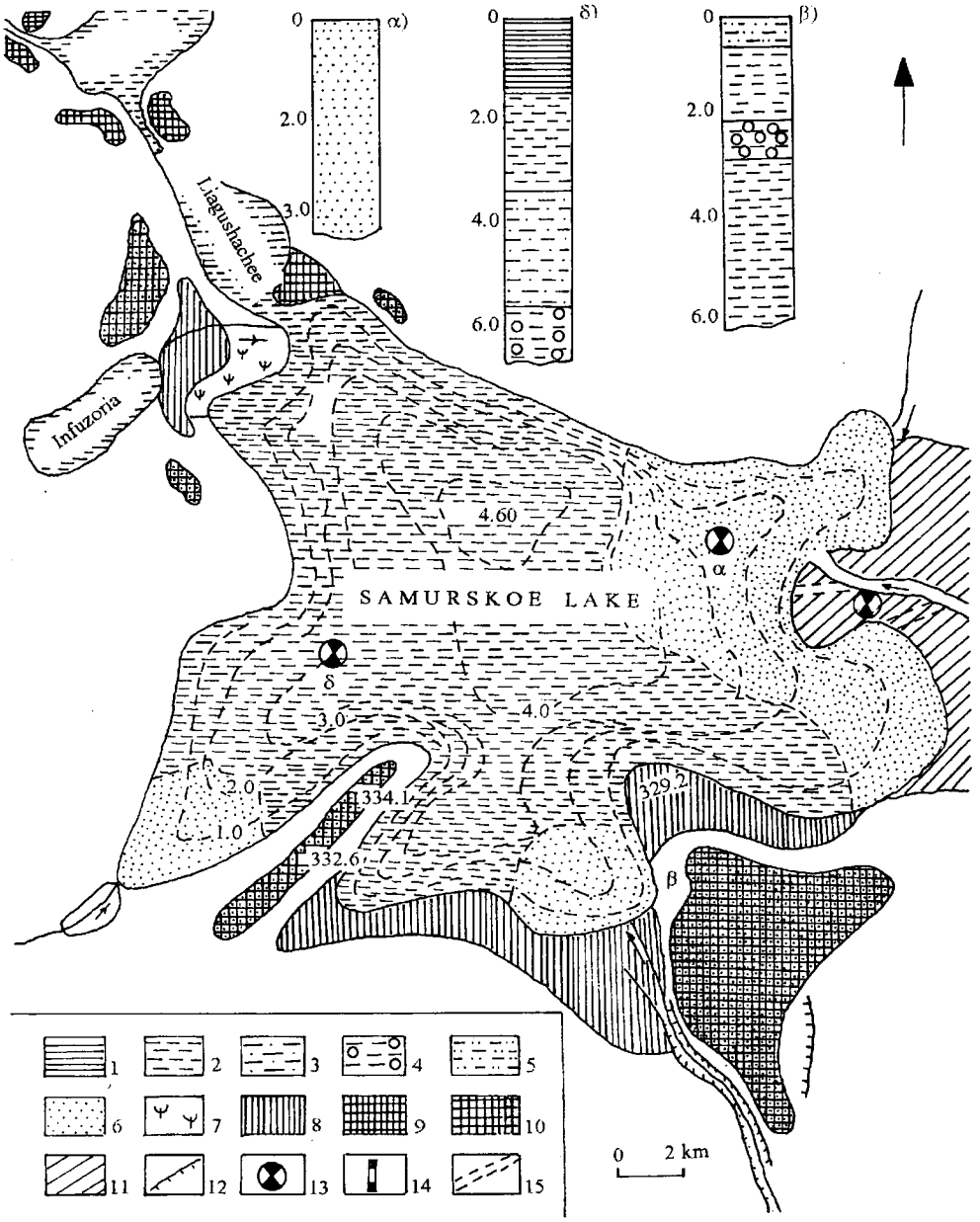
The localities of the sampling including the morphogenetic precipitation complexes in the water surface of Samurskoe Lake are illustrated in Text-fig. 8.1.

The quantitative data of the spore-pollen assemblage of the recent sediments of the Samurskoe Lake including the quantity of the redeposited pollen grains are illustrated in Text-fig. 8.2. The dominance of the quantity of the *Alnus* pollen grains is well shown. From the point of view of our present study the occurrences of the redeposited sporomorphs are also worth of mentioning.

The different taxa of the redeposited spores and pollen grains are presented in four plates (Plate 8.1.-8.4.). The following form-genera and species were observed:

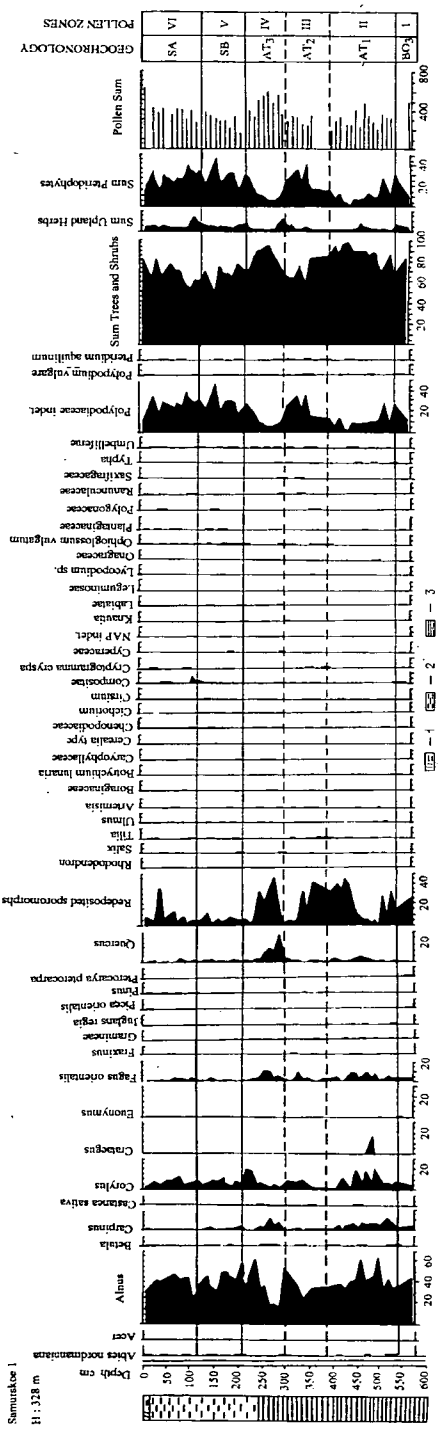
Sporites

Dandotiaspora dilata (MATH.) SAH, KAR et SINGH 1971 (Plate 8.1., fig. 1); *Leiotriletes sphagnoides* KEDVES et SIMONCSICS 1964, (Plate 8.1., fig. 2); *Obtusisporis obtusangulus* (POTONIÉ 1934) JANSONIUS et HILLS 1976 (Plate 8.1., fig. 3); *Gleicheniidites senonicus* ROSS 1949 (Plate 8.1., fig. 4); *Gleicheniidites umbonatus* (BOLKHOVITINA 1953) KRUTZSCH 1959 (Plate 8.2., figs. 3,15); DEÁK (1965) published this species from the Aptian from Transdanubia (Hungary). Based on the monograph of BOLKHOVITINA (1968) the occurrence of this species is from the Hauterivian until the Tertiary; *Gleicheniidites (Triremisporites) latifolius* DÖRING 1965b (Plate 8.2., fig. 4); *Gleicheniidites (Gleicheniidites) major* DÖRING 1965b (Plate 8.2., fig. 5); *Gleicheniidites (Triremisporites) rasilis* (BOLKHOVITINA 1953) KRUTZSCH 1959, (Plate 8.2., fig. 7-11); *Gleicheniidites (Triremisporites) rasilis/posttriplex* (Plate 8.2., fig. 12); *Gleicheniidites (Triplexisporis) posttriplex* DÖRING 1965a (Plate 8.2., figs. 13,14,16,17, plate 8.3., figs. 1,2); *Clavifera triplex* (BOLKHOVITINA 1953) BOLKHOVITINA 1966 (Plate 8.3., figs. 3,4); DEÁK and COMBAZ (1967) published this species as *Gleicheniidites triplex* and for occurrences the Aptian-Albian and Lower Cenomanian were given. HERNGREEN (1973) published this type of spore from the Valanginian sediments in the eastern Netherlands. *Clavifera rudis* BOLKHOVITINA 1968 (Plate 8.3., figs. 5-10); *Clavifera tuberosa* BOLKHOVITINA 1968 (Plate 8.3., figs. 11-15); *Asbeckiasporites* fsp. (Plate 8.2., fig. 1); *Asbeckiasporites wirthi* v.d. BRELIE 1964 (Plate 8.2., figs. 2,6); *Biretisporites* fsp. (Plate 8.1., fig. 5); *Maculatisporites microverrucatus* DÖRING 1964 (Plate 8.1., fig. 6); *Vadaszisporites sacali* DEÁK et COMBAZ 1967 (Plate 8.1., fig. 7); *Macroleptolepidites* fsp.$_1$ (Plate 8.1., figs. 8,9); *Macroleptolepidites* fsp.$_2$ (Plate 8.1., fig. 10); cf. *Macroleptolepidites* fsp. (Plate 8.1., fig. 11); *Polypodiaceoisporites* ex gr. *hungaricus* KEDVES 1961, (Plate 8.1., figs. 12-15); *Distaltriangulisporites maximus* SINGH 1971 (Plate 8.1., figs. 16-21). SINGH (1971) described this species from the Middle Albian, Loon River Formation of the Peace River Area, Canada. WINGATE (1980) published the *D. perplexus* (SINGH) SINGH 1971, and *D. mutabilis* SINGH 1971 from the Denton Shale Member of the Bokchito Formation (Lower Cretaceous, Albian) in Southern Oklahoma, U.S.A.



Text-fig. 8.1.

Morpholithogenetic precipitation complexes in the water surface of Samurskoe Lake.
1 - clays; 2 - detrituses; 3 - loams; 4 - loams with inclusions of ferrit and sulfide concretions; 5 - loamy sand; 6 - sand; 7 - low swamply near-lake areas (0.2-0.5 m); 8 - first terrace (0.7-2.5 m); 9 - second terrace (3.0-4.0 m); 10 - third terrace (4.7-7.0 m); 11 - delta plains; 12 - escarps; 13 - bore-holes; 14 - pit holes; 15 - dead river-beds.



Text-fig. 8.2.

Spore-pollen diagram of Samurskoe Lake sediments.
1 – soil; 2 – detrituses; 3 – clays.

Pollenites

Gymnospermatophyta

Pteruchipollenites thomasii COUPER 1958 (Plate 8.4., fig. 1). Occurrences: Jurassic, Great Britain, COUPER (1958), Plate 26, figs. 10-12. Similar forms: *Pinus* sp. *Haploxylon,* Aptian-Albian, Turgai and Aral Region, KRUCHININA and ROMANOVSKAYA (1964), Plate XX, fig. 7, *Pseudopinus textilis* BOLKH., Valanginian, Baikal Region, SEDOVA (1964), (Plate LVIII, fig. 9); *Parvisaccites radiatus* COUPER 1958 (Plate 8.4., fig. 2). Synonymy by SINGH (1964), a number of occurrences in the monograph of SINGH (1971) from "Late Jurassic to early Cenomanian". Occurrences: Wealdian and Aptian; Great Britain, COUPER (1958), Plate 29, figs. 5-8, plate 30, figs. 1,2; Pre-Barremian - L. Albian SW Scania, Sweden, VAJDA-SANTIVANEZ (1998b), Plate 5 D,E. Similar forms: *Dacrydium* sp. 1,2, Aptian, Bug, ZAUER and TABACHNIKOVA (1964), Plate IV, figs. 2,3, *Cedrus cristata* ZAUER, Aptian-Albian, Turgai and Aral Region, KRUCHININA and ROMANOVSKAYA (1964), Plate XX, figs. 8,9; *Cedrus cristata* ZAUER, Hauterivian-Barremian, Ryavskinskaya, Bore-hole 3-P, KOLT'ZOVA, KRUCHININA and STEL'MAK (1964), Plate XLVIII, fig. 5; *Parvisaccites* fsp.$_1$ (Plate 8.4., fig. 3). Similar forms: *Cedrus cristata* SAUER, Aptian-Albian, Barabinskaya Bore-hole 1-P, KOLT'ZOVA, KRUCHININA and STEL'MAK (1964), Plate LIV, fig. 8; *Cedrus cristata* ZAUER, Valanginian, Baikal Region, SEDOVA (1964), Plate LVII, fig. 6; *Parvisaccites enigmatus* COUPER 1958 (Plate 8.4., fig. 4). Occurrences: Middle Jurassic, Great Britain, COUPER (1958), Plate 30, figs. 3-5; *Parvisaccites* fsp.$_2$ (Plate 8.4., fig. 5). Similar forms: *Cedrus pachyderma* ZAUER, Hauterivian-Barremian, N. Ural, KOLT'ZOVA and MARTYNOVA (1964), Plate XLI figs. 3-5; *Alisporites rotundus* ROUSE 1959 (Plate 8.4., fig. 6). Similar forms: Pinus sp. 1,2, *Haploxylon,* Aptian, Bug, ZAUER and TABACHNIKOVA (1964), Plate IV, figs. 4,5; *Cedrus cristata* ZAUER, Aptian, Bug, ZAUER and TABACHNIKOVA (1964), Plate VI, fig. 9; *Cedrus pachyderma* ZAUER, Albian, Turkmenia, PANOVA (1964), Plate XIII, fig. 2; *Pinus divulgata* BOLCH., Valanginian, Berezovska Bore-hole 1-P, KOLT'ZOVA, KRUCHININA and STEL'MAK (1964), Plate XLV, fig. 8; Pinus sp. 4, *Haploxylon*, Aptian-Albian, Barabinskaya, Bore-hole 1-P, KOLT'ZOVA, KRUCHININA and STEL'MAK (1964), Plate LV, fig. 4.

Discussion and Conclusions

The redeposited forms may be characterized in the first place with the spores of *Gleicheniaceae.* As characteristic forms *Gleicheniidites (Triremisporites) rasilis, Clavifera triplex, C. rudis* and *C. tuberosa* may be emphasized.

DÖRING (1965a) published the taxonomy and the stratigraphy of the taxa of *Gleicheniidites* and *Trubasporites* from the Jurassic/Cretaceous boundary. The *gleicheniaceous* spores are rich in the Wealden, Valanginian and Hauterivian. *Gleicheniidites (Triplexisporites) posttriplex* DÖR. and *G. (Triremisporites) rasilis* (BOLCH.) DÖR. was published by DÖRING (1966) from the "Lower Cretaceous H" (± Valanginian) of South Brandenburg (Germany). BOLKHOVITINA (1966), p. 11 wrote the following: "During the Early Cretaceous *Gleicheniaceae* got an enormous distribution throughout the Earth's surface. Their abundant remnants, especially their spores, were found in many localities of Eurasia, North America and Australia and it is with this time that coincides the greatest polymorphism of the family." JUHÁSZ (1977) pointed out, that the spores of the *Gleicheniaceae* are important in the spore-pollen assemblages of the Upper Barremian

to Lower Aptian of the Mts. Bakony (Hungary) and Albian sediments of the Mts. Villány. Based on the results of VAJDA-SANTIVANEZ (1998a) in the late Aptian and early Albian the relative frequency of the genus *Gleicheniidites* increases. *Clavifera triplex* was published from southern Scandinavia and according to several authors she emphasized, that the *Gleicheniidites bulbosus* [=*Gleicheniidites (Triremisporites) rasilis*] extinct at the end of the early Albian.

In addition to the *Gleicheniaceae* spores the relative abundance of the spores of *Distaltriangulisporites maximus* are also important concerning the age of the redeposited sediments. SINGH (1971) published this species from this form-genus from the Middle Albian of Canada. WINGATE (1980) published two form-species of *Distaltriangulisporites* from Lower Albian sediments in Southern Oklahoma, U.S.A.

It is worth mentioning the lack of the pollen grains of *Operculati (Classopollis)*, and other characteristic *gymnosperm* pollen grains such as *Spheripollenites, Monosulcites*, etc. It seems that the resistance of the sporopollenin of the saccate forms is extremely important in contrast to the other *gymnosperm* pollen grains. The lack of the striate *Schizaeaceae* spores is also worth mentioning taking into consideration the paper of VAJDA-SANTIVANEZ (1998b).

Finally, the redeposited sediments are without doubt of Lower Cretaceous age. Nearer Aptian and/or Albian stages are probable.

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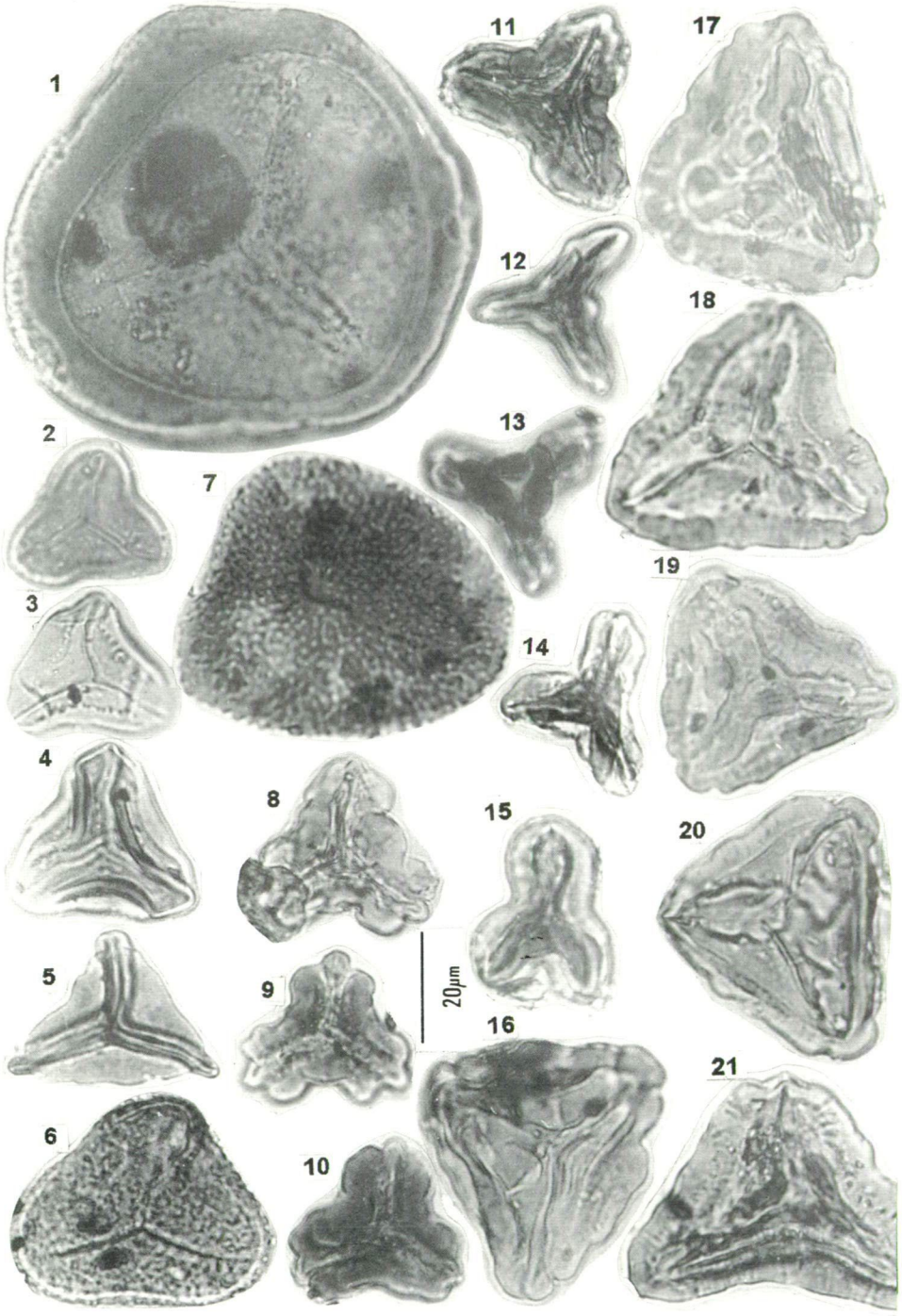
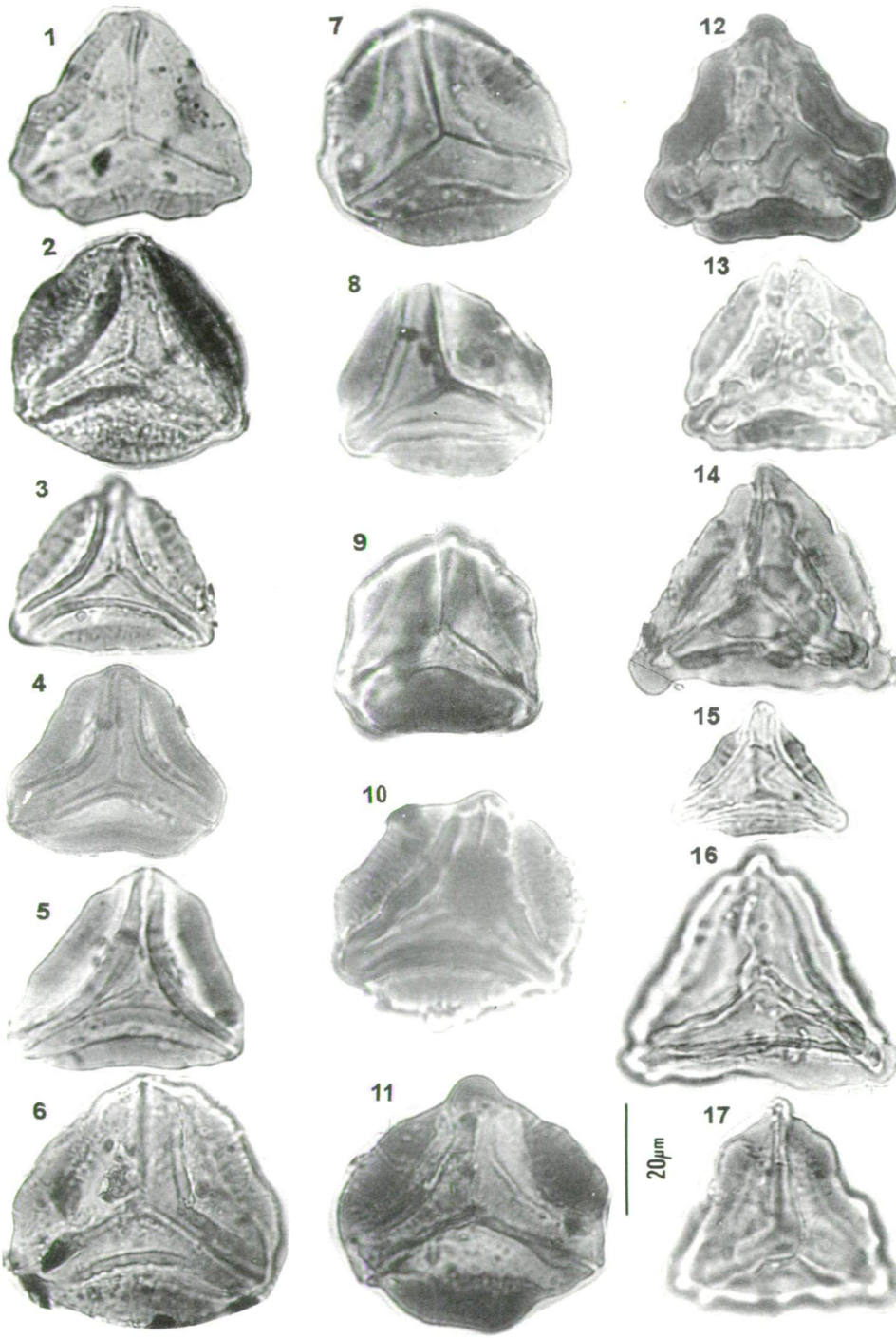


Plate 8.1.



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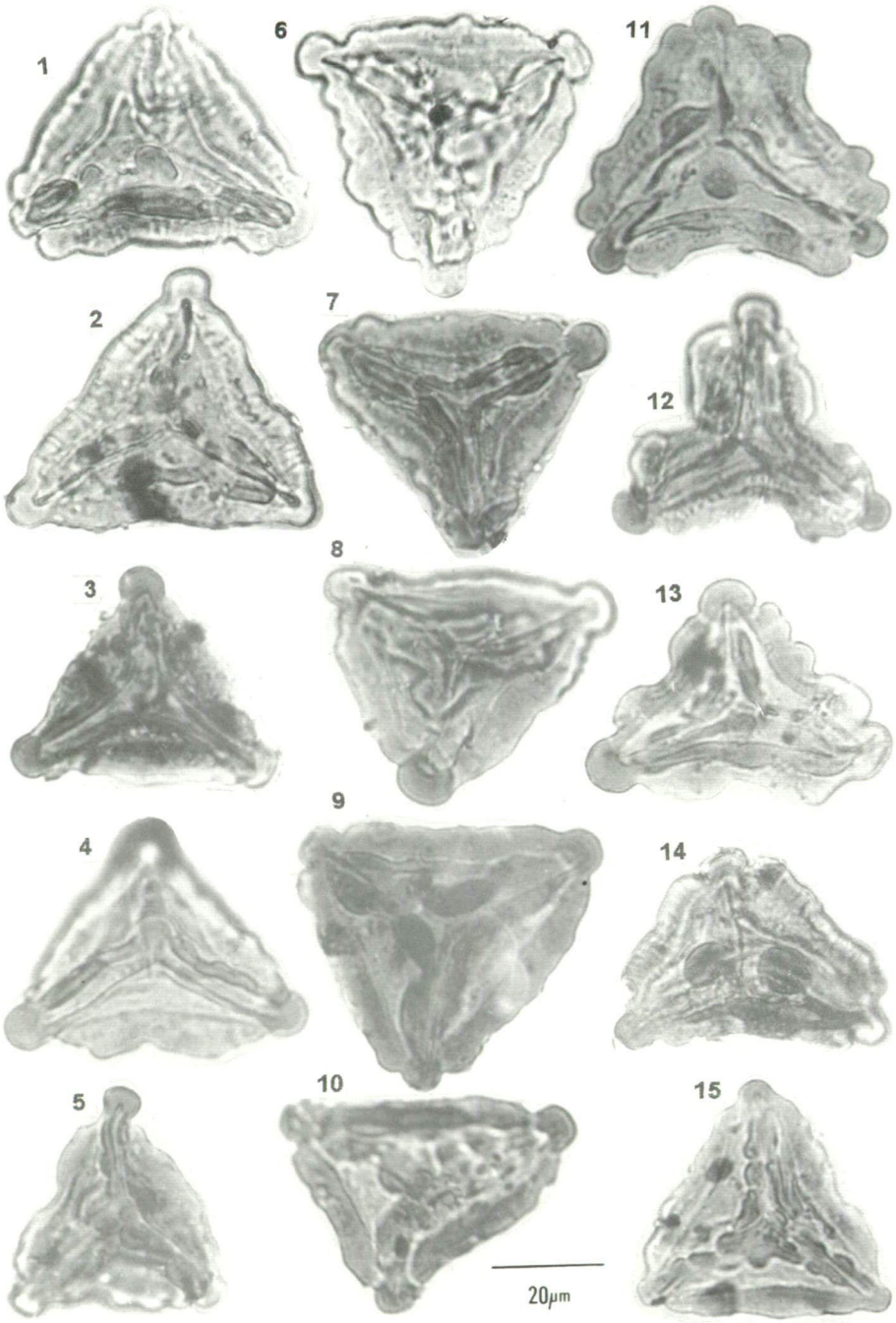

Plate 8.3.

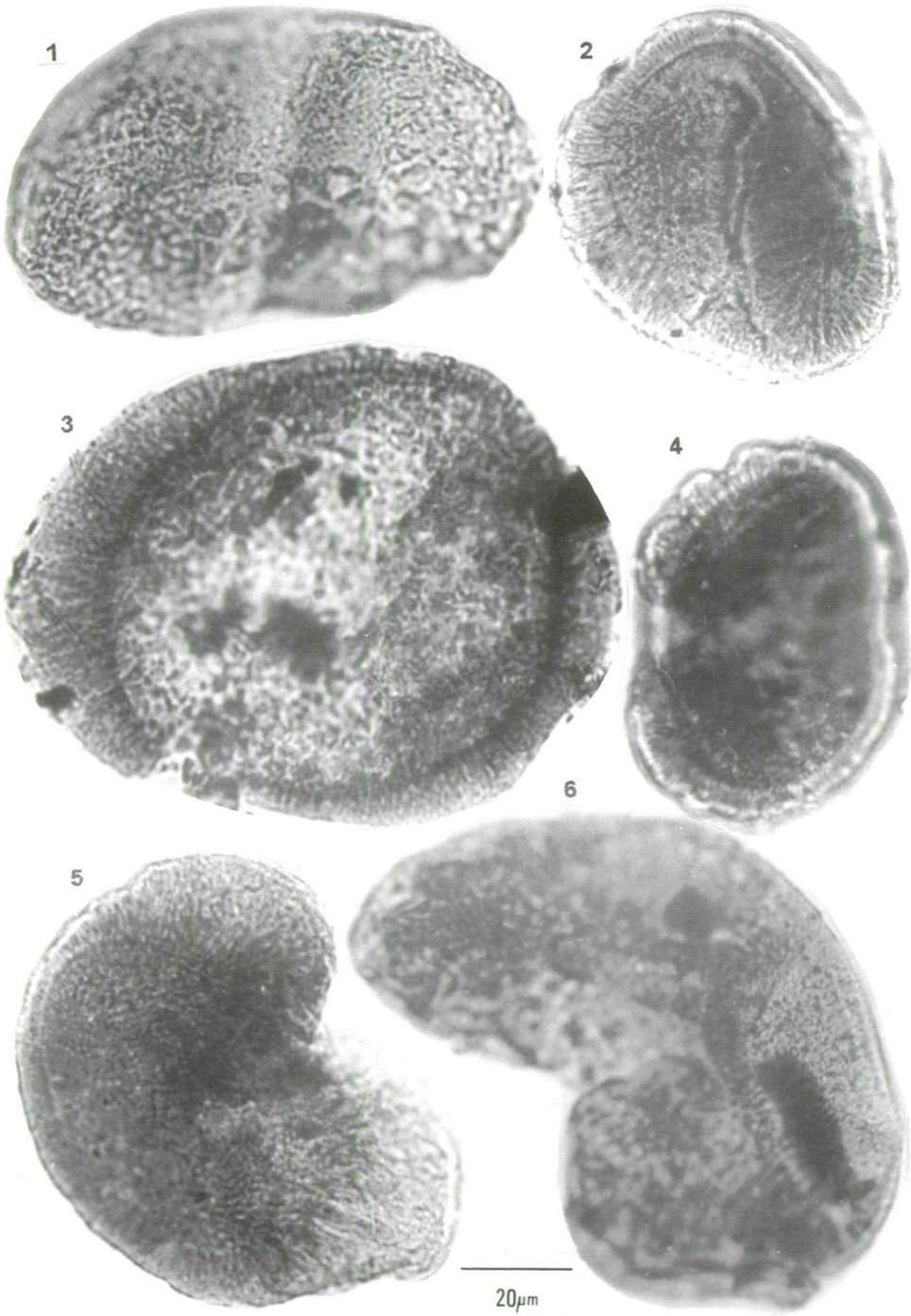

Plate 8.4.

Plate 8.1.

1. *Dandotiaspora dilata* (MATH.) SAH, KAR et SINGH 1971, slide: N-19-5, cross-table number: 21.4/123.8.
2. *Leiotriletes sphagnoides* KEDVES et SIMONCSICS 1964, slide: N-17-1, cross-table number: 24.3/144.3.
3. *Obtusisporis obtusangulus* (POTONIÉ 1934) JANSONIUS et HILLS 1976, slide: N-17-1, cross-table number: 15.9/129.8.
4. *Gleicheniidites senonicus* ROSS 1949, slide: N-19-4, cross-table number: 8.5/145.6.
5. *Biretisporites* fsp., slide: N-19-1, cross-table number: 18.3/125.2.
6. *Maculatisporites microverrucatus* DÖRING 1964, slide: N-19-4, cross-table number: 25.7/125.3.
7. *Vadaszisporites sacali* DEÁK et COMBAZ 1967, slide: N-17-3, cross-table number: 17.3/128.6.
8. *Macroleptolepidites* fsp.$_1$, slide: N-19-3, cross-table number: 22.1/138.8.
9. *Macroleptolepidites* fsp.$_1$, slide: N-19-1, cross-table number: 19.6/126.4.
10. *Macroleptolepidites* fsp.$_2$, slide: N-19-3, cross-table number: 16.8/144.9.
11. Cf. *Macroleptolepidites* fsp., slide: N-19-4, cross-table number: 23.5/134..3.
12. *Polypodiaceoisporites* fsp. ex gr. *hungaricus* KEDVES 1961, slide: N-19-5, cross-table number: 15./142.2.
13. *Polypodiaceoisporites* fsp. ex gr. *hungaricus* KEDVES 1961, slide: N-17-1, cross-table number: 17.2/129.4.
14. *Polypodiaceoisporites* fsp. ex gr. *hungaricus* KEDVES 1961, slide: N-19-5, cross-table number: 14.3/141.7.
15. *Polypodiaceoisporites* fsp. ex gr. *hungaricus* KEDVES 1961, slide: N-17-5, cross-table number: 16.5/131.7.
16. *Distaltriangulisporites maximus* SINGH 1971, slide: N-19-5, cross-table number: 24.3/125.7.
17. *Distaltriangulisporites maximus* SINGH 1971, slide: N-17-2, cross-table number: 21.2/140.0.
18. *Distaltriangulisporites maximus* SINGH 1971, slide: N-17-3, cross-table number: 16.9/137.0.
19. *Distaltriangulisporites maximus* SINGH 1971, slide: N-19-2, cross-table number: 10.1/132.2.
20. *Distaltriangulisporites maximus* SINGH 1971, slide: N-17-2, cross-table number: 21.9/133.9.
21. *Distaltriangulisporites maximus* SINGH 1971, slide: N-17-3, cross-table number: 5.5/138.4.

Plate 8.2.

1. *Asbeckiasporites* fsp., slide: N-19-1, cross-table number: 3.9/138.6.
2. *Asbeckiasporites wirthi* v.d. BRELIE 1964, slide: N-2-5, cross-table number: 25.8/136.7.
3. *Gleicheniidites umbonatus* (BOLKHOVITINA 1953) BOLKHOVITINA 1968, slide: N-17-1, cross-table number: 9.8/135.9.
4. *Gleicheniidites (Triremisporites) latifolius* DÖRING 1965b, slide: N-19-3, cross-table number: 25.2/139.3.
5. *Gleicheniidites (Gleicheniidites) major* DÖRING 1965b, slide: N-19-2, cross-table number: 5.8/136.6.
6. *Asbeckiasporites wirthi* v.d. BRELIE 1964, slide: N-19-4, cross-table number: 26.7/128.9.
7. *Gleicheniidites (Triremisporites) rasilis* (BOLKHOVITINA 1953) KRUTZSCH 1959 syn.: *Gleicheniidites bulbosus* KEMP 1970, slide: N-17-9, cross-table number: 7.5/133.6.
8. *Gleicheniidites (Triremisporites) rasilis* (BOLKHOVITINA 1953) KRUTZSCH 1959 syn.: *Gleicheniidites bulbosus* KEMP 1970, slide: N-19-2, cross-table number: 23.6/125.9.
9. *Gleicheniidites (Triremisporites) rasilis* (BOLKHOVITINA 1953) KRUTZSCH 1959, slide: N-19-5, cross-table number: 14.2/128.7.
10. *Gleicheniidites (Triremisporites) rasilis* (BOLKHOVITINA 1953) KRUTZSCH 1959, slide: N-17-2, cross-table number: 7.2/140.2.
11. *Gleicheniidites (Triremisporites) rasilis* (BOLKHOVITINA 1953) KRUTZSCH 1959, slide: N-19-3, cross-table number: 23.3/129.3.
12. *Gleicheniidites (Triremisporites) rasilis/posttriplex*, intermediate form; slide: N-17-1, cross-table number: 24.4/137.9.
13. *Gleicheniidites (Triplexisporis) posttriplex* DÖRING 1965a, slide: N-17-3, cross-table number: 21.3/145.9.
14. *Gleicheniidites (Triplexisporis) posttriplex* DÖRING 1965a, slide: N-19-5, cross-table number: 17.8/138.4.
15. *Gleicheniidites umbonatus* (BOLKHIVITINA 1953) BOLKHOVITINA 1968, slide: N-17-5, cross-table number: 23.2/131.2.

16. *Gleicheniidites (Triplexisporis) posttriplex* DÖRING 1965a, slide: N-19-1, cross-table number: 13.9/132.1.
17. *Gleicheniidites (Triplexisporis) posttriplex* DÖRING 1965a, slide: N-19-5, cross-table number: 24.6/133.3.

Plate 8.3.

1. *Gleicheniidites (Triplexisporites) posttriplex* DÖRING 1965a, slide: N-19-5, cross-table number: 21.3/138.3.
2. *Gleicheniidites (Triplexisporites) posttriplex* DÖRING 1965a, slide: N-19-5, cross-table number: 14.2/132.2.
3. *Clavifera triplex* (BOLKHOVITINA 1953) BOLKHOVITINA 1966, slide: N-19-2, cross-table number: 8.5/133.5.
4. *Clavifera triplex* (BOLKHOVITINA 1953) BOLKHOVITINA 1966, slide: N-17-3, cross-table number: 13.4/133.5.
5. *Clavifera rudis* BOLKHOVITINA 1968, slide: N-17-3, cross-table number: 22.3/132.9.
6. *Clavifera rudis* BOLKHOVITINA 1968, slide: N-19-2, cross-table number: 18.6/130.0.
7. *Clavifera rudis* BOLKHOVITINA 1968, slide: N-17-5, cross-table number: 12.6/142.7.
8. *Clavifera rudis* BOLKHOVITINA 1968, slide: N-17-3, cross-table number: 7.8/138.2.
9. *Clavifera rudis* BOLKHOVITINA 1968, slide: N-17-4, cross-table number: 18.1/140.8.
10. *Clavifera rudis* BOLKHOVITINA 1968, slide: N-17-1, cross-table number: 14.9/140.0.
11. *Clavifera tuberosa* BOLKHOVITINA 1968, slide: N-17-4, cross-table number: 23.2/125.9.
12. *Clavifera tuberosa* BOLKHOVITINA 1968, slide: N-17-5, cross-table number: 8.4/145.9.
13. *Clavifera tuberosa* BOLKHOVITINA 1968, slide: N-19-4, cross-table number: 27.2/144.2.
14. *Clavifera tuberosa* BOLKHOVITINA 1968, slide: N-19-3, cross-table number: 25.8/132.2.
15. *Clavifera tuberosa* BOLKHOVITINA 1968, slide: N-19-1, cross-table number: 7.8/137.9.

Plate 8.4.

1. *Pteruchipollenites thomasii* COUPER 1958, slide: N-2-1, cross-table number: 13.5/130.8.
2. *Parvisaccites radiatus* COUPER 1958, slide: N-19-1, cross-table number: 26.4/130.9.
3. *Parvisaccites* fsp.$_1$, slide: N-17-1, cross-table number: 8.7/127.2.
4. *Parvisaccites enigmatus* COUPER 1958, slide: N-17-3, cross-table number: 20.0/125.3.
5. *Parvisaccites* fsp.$_2$, slide: N-19-1, cross-table number: 11.8/145.6.
6. *Alisporites rotundus* ROUSE 1959, slide: N-17-3, cross-table number: 12.1/137.6.

9. EXPERIMENTAL INVESTIGATIONS ON THE POLLEN GRAINS OF PUNICA GRANATUM L.

M. KEDVES and M. MADARÁSZ

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701 Szeged, P.O. Box 993, Hungary

Abstract

Pollen grains isolated from buds and flowers were investigated with the following methods: 1. High temperature effect at 200 °C during 60 s, 5 and 10 hours. 2. Hydratation at 30 °C during 24 hours. The P/E ratio and the length polar axis were investigated quantitatively. The results of the experiments are compared with the data of the dry fresh pollen grains.

Key words: Experimental Palynology, recent, *Punica granatum*, LM.

Introduction

Punica granatum L. is an important species in the Mediterranean Regions (SOÓ and JÁVORKA, 1951, LAGOS, 1997, etc.). There are several publications concerning the pollen morphology of this species (ERDTMAN, 1952, THANIKAIMONI, 1972, 1973, 1976, 1980, 1986, TISSOT, 1990, TISSOT and VAN DER HAM, 1994). The family or the genus was represented in the Tertiary of the Northern Hemisphere (cf. POTONIÉ, 1934, POTONIÉ and VENITZ, 1934, KEDVES, 1978). Because of the interesting flower morphology we have chosen this species also for experimental palynological investigation.

The aim of our contribution is to compare the LM morphology of the mature and immature pollen grains in different conditions.

Materials and Methods

The pollen material for investigations was collected by Dr. M. KEDVES on the 26th April 1999 in Sousse Tunesia during the 4th Symposium of African Palynology.

The experiments are as follows:

T-9-31. - dry immature pollen grains.
T-9-32. - immature pollen grains hydrated at 30 °C during 24 hours.
T-9-33. - immature pollen grains heated at 200 °C during 1 hour.
T-9-34. - immature pollen grains heated at 200 °C during 5 hours.
T-9-35. - immature pollen grains heated at 200 °C during 10 hours.
T-9-36. - dry mature pollen grains.
T-9-37. - mature pollen grains hydrated at 30 °C during 24 hours.

T-9-38. - mature pollen grains heated at 200 °C during 1 hour.
T-9-39. - mature pollen grains heated at 200 °C during 5 hours.
T-9-40. - mature pollen grains heated at 200 °C during 10 hours.
The pollen grains were mounted in glycerine-jelly hydrated at 39.6%.

Results

Qualitative data

Immature pollen grains. - in dry condition amb is more or less globular (Plate 9.1., fig. 1), some hydrated forms in polar position are superficially similar to the *Interporopollenites* fossil fgen. which are characteristic for the Senonian sediments in the *Normapolles* Region (Plate 9.1., figs. 2,3).

Mature pollen grains. - in dry condition the tricolporate longaxones characteristic features are well shown (Plate 9.1., figs. 6,7). The hydrated forms (Plate 9.1., figs. 8-13) are similar to the immature pollen grains (Plate 9.1., figs. 1-5).

It is interesting that the more or less isodiametric form of the immature pollen grains after heating have not altered in a significant measure (Plate 9.1., figs. 14-16, plate 9.2., figs. 4-7, plate 9.1., figs. 20-22, plate 9.3., figs. 1-3, plate 9.1., figs. 26-28, plate 9.3., figs. 6-8).

Regarding the mature pollen grains we have not observed important alterations in the symmetry after heating (Plate 9.1., figs. 17-19, plate 9.2., figs. 8-10, plate 9.1., figs. 23-25, plate 9.3., figs. 4,5, plate 9.1., figs. 29-31, plate 9.3., figs. 9-12). It is worth of mentioning that the structure of the apertural area after heating is well shown.

Quantitative data

Explications: D = dry, H = hydrated.

1. Immature pollen grains isolated from buds (Plate 9.1., figs. 1-5; fig. 1 D, figs. 2-5 H, plate 9.2., fig. 1 H).

1.1. P/E ratio (D) from 1.0 until 1.3, maxima: 1.0 (31.0%), 1.07 (27.0%) average: 1.07.

1.2. P/E ratio (H) from 1.0 until 1.4, maximum: 1.0 (42.5%), average: 1.05.

1.3. Polar axis (D) from 17.5 until 25.0 µm, maximum: 20.0 µm (45.0%), average: 19.9 µm.

1.4. Polar axis (H) from 17.5 until 25.0 µm, maximum: 20.0 µm (43.0%), average: 21.0 µm.

2. Mature pollen grains (Plate 9.1., figs. 6-13; figs. 6,7 D, figs. 8-13 H, plate 9.2., figs. 2,3 H).

2.1. P/E ratio (D) from 1.4 until 2.0, maxima: 1.6 (34.0%), 1.7 (31.0%), average: 1.66.

2.2. P/E ratio (H) from 1.0 until 1.13, maximum: 1.0 (53.0%), average: 1.04.

2.3. Polar axis (D) from 25.0 until 32.5 µm, maximum: 30.0 µm (40.0%), average: 29.5 µm.

2.4. Polar axis (H) from 20.0 until 25.0 µm, maximum: 22.5 µm (54.0%), average: 22.0 µm.

3. The per cents of the position of the heated pollen grains are as follows.

3.1. Immature pollen grains (Plate 9.1., figs. 14-16, 20-22, 26-28, plate 9.2., figs. 4-7, plate 9.3., figs. 1-3, 6-8).

duration of heating	position polar	position equatorial
1 hour	34.0%	66.0%
5 hours	37.5%	62.5%
10 hours	23.0%	77.0%

3.2. Mature pollen grains (Plate 9.1., figs. 17-19, 23-25, 29-31, plate 9.2., figs. 8-10, plate 9.3., figs. 4,5, 9-12.)

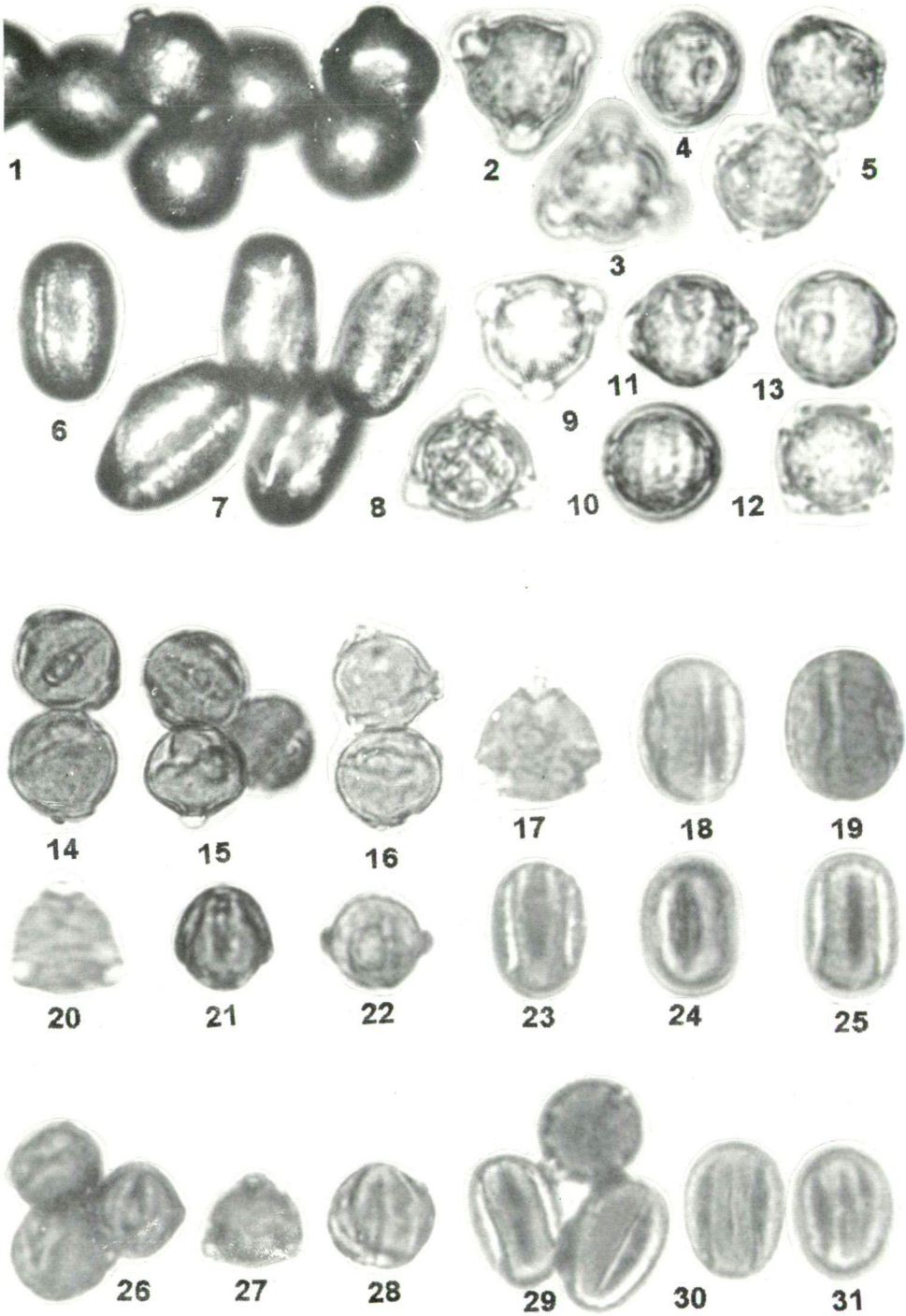
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Plate 9.1.

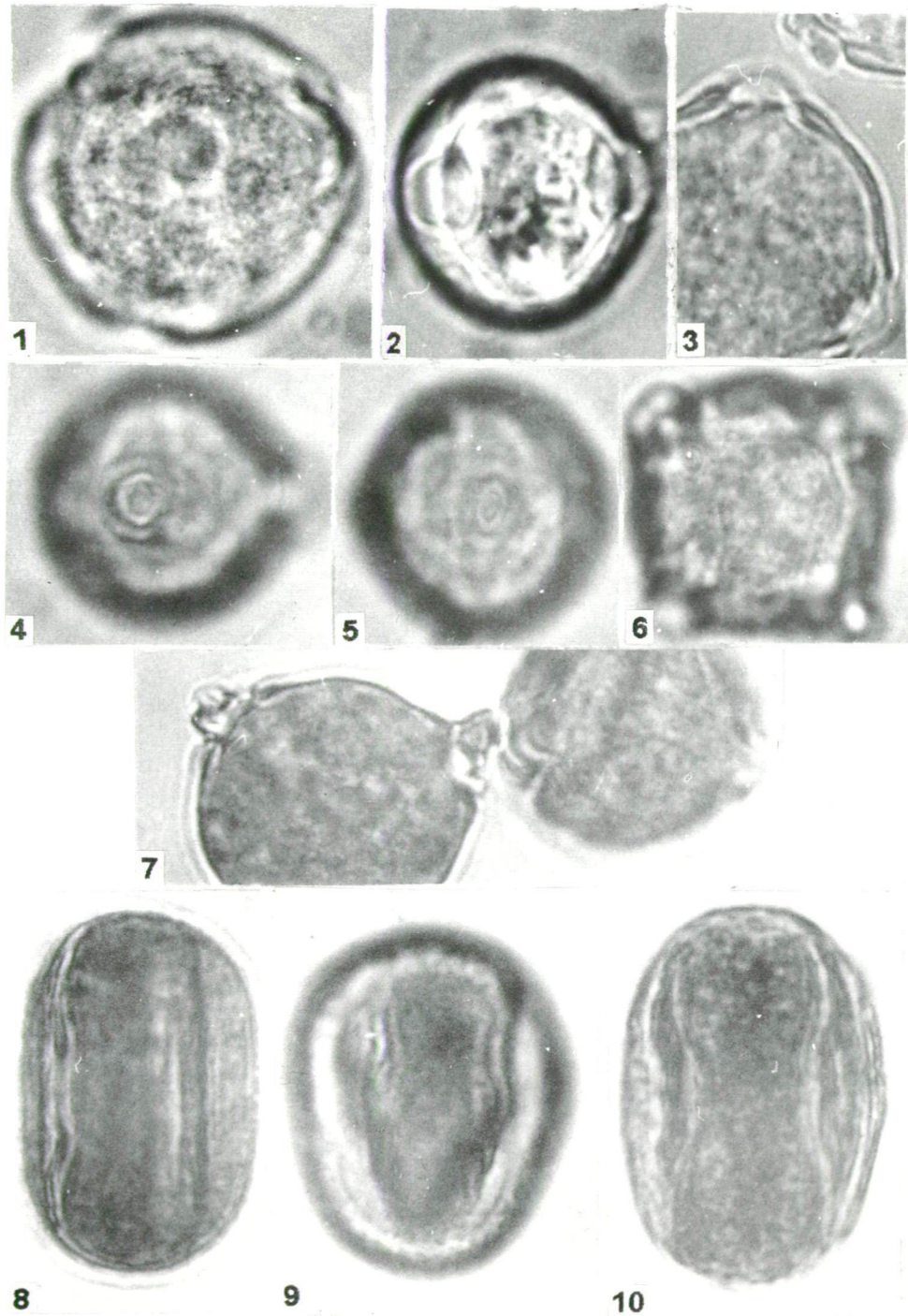

Plate 9.2.

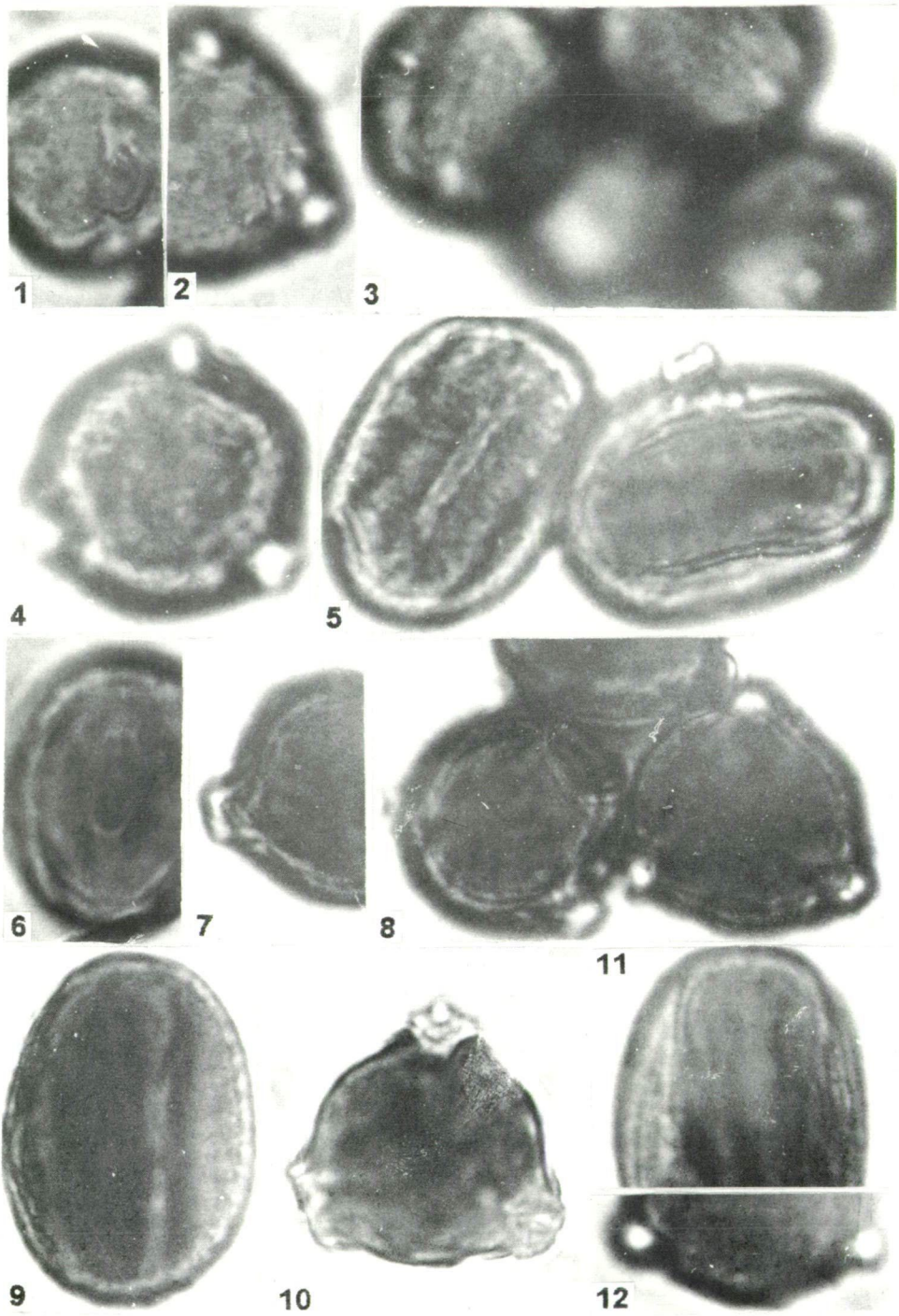

Plate 9.3.

duration of heating	position polar	position equatorial
1 hour	21.5%	78.5%
5 hours	20.0%	80.0%
10 hours	17.5%	82.5%

Discussion and Conclusions

Based on our new results we can emphasized the following:

1. The similarity to the early (Upper Cretaceous) *Interporopollenites* fgen. of the hydrated immature pollen grains.

2. The similarity in the symmetry of the dry and hydrated immature and the mature hydrated pollen grains.

3. The constancy of the symmetry of the pollen grains after heating.

Plate 9.1.

1-31. *Punica granatum* L., light microscopic pictures. Magnification of all pictures: 1000x.
1. Dry pollen grains isolated from buds.
2-5. Hydrated pollen grains isolated from buds.
6-7. Dry, mature pollen grains.
8-13. Hydrated mature pollen grains.
14-16. Pollen grains isolated from buds, heated during 1 hour at 200 °C.
17-19. Mature pollen grains heated during 1 hour at 200 °C.
20-22. Pollen grains isolated from buds, heated during 5 hours at 200 °C.
23-25. Mature pollen grains heated during 5 hour at 200 °C.
26-28. Pollen grains isolated from buds, heated during 10 hours at 200 °C.
29-31. Mature pollen grains heated during 10 hour at 200 °C.

Plate 9.2.

1-10. *Punica granatum* L., light microscopic pictures. Magnification of all pictures: 2500x.
1. Hydrated pollen grains isolated from buds.
2,3. Hydrated pollen grains isolated from flowers.
4-7. Pollen grains isolated from buds, heated during 1 hour at 200 °C.
8-10. Mature pollen grains heated during 1 hour at 200 °C.

Plate 9.3.

1-12. *Punica granatum* L., light microscopic pictures. Magnification of all pictures: 2500x.
1-3. Pollen grains isolated from buds, heated during 5 hour at 200 °C.
4,5. Mature pollen grains heated during 5 hour at 200 °C.
6-8. Pollen grains isolated from buds, heated during 10 hour at 200 °C.
9-12. Mature pollen grains heated during 10 hour at 200 °C.

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10. DUHOUX EFFECT ON INAPERTURATE GYMNOSPERM AND ANGIOSPERM POLLEN GRAINS

M. KEDVES, M. MADARÁSZ, A. SZÉCSÉNYI, A. HORVÁTH, ZS. TERBE, ESZTER HORVÁTH, A. BORSODI, K. DOBÓ, E. KOVÁCS and T. KANCSÁR

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

The TEM and LM method was used during our investigation. The Duhoux effect was investigated by the TEM on the pollen grains of *Taxus baccata* L. after X-ray irradiation and hydratation. Hydratation was applied for the experimental material (*Larix decidua* MILL., *Metasequoia glyptostroboides* HU et CHENG, *Biota orientalis* ENDL., *Juniperus virginiana* L., *J. chinensis* L., *Taxus baccata* L., *T. baccata* cv. *aurea*, *T. baccata* cv. *compacta*, *Populus alba* L.) at the LM studies. Different kinds of staining and preparation methods were used at the pollen grains of *Taxus baccata*. The new results raised the necessity of further experimental studies in this field to get more LM and TEM data.

Key words: Palynology, recent, Duhoux effect, LM, TEM.

Introduction

DUHOUX (1972, 1975, 1979) established at the inaperturate pollen grains of some *gymnosperm* taxa (*Cupressaceae, Taxaceae, Taxodiaceae*) peculiar in vitro germination. The exine tears after hydratation in consequence of an extreme swelling of the intine. During our previous experimental investigations we observed this phenomenon after X-ray irradiation (KEDVES and UNGVÁRI, 1996) and partial dissolution as well (KEDVES, KÁROSSY and BORBOLA, 1997, KEDVES et al., 1998). Since we have observed the same phenomenon in consequence of different influences we introduced the following term: "Duhoux effect".

In this paper we present some TEM data on the X-ray irradiated and hydrated pollen grains of *Taxus baccata*, and the LM results of the hydrated inaperturate *gymnosperm* and *angiosperm* pollen grains.

The aim of this contribution was to get new ultrastructural data for the Duhoux effect, and further LM data for the hydratation process. Moreover an attempt was made to establish some "post hydratation" alterations in consequence of the different stains, or the TEM fixation and embedding processes.

Materials and Methods

For TEM investigations pollen grains of *Taxus baccata* were chosen. Experiment No: 1/7-1744. Duration of the irradiation: 1 hour with CuKα X-ray (35 KV, 20 mA).

BRON-OM1 apparatus in the Radiological Laboratory of the Department of Mineralogy, Petrology and Geochemistry of the J.A. University. Experiment No: 1/7-1361. Hydratation with 5 ml distilled water at 30 °C during 24 hours. The experimental pollen material was postfixed with OsO_4 (aq.dil.), dehydrated and embedded in Araldite (Durcupan, Fluka). The ultrathin sections were made on a Porter Blum ultramicrotome in the E.M. Laboratory of the Institute of Biophysics of the Biological Research Center of the Hungarian Academy of Sciences. The pictures were taken on a TESLA BS-540 TEM (resolution 6-7 Å).

For LM studies all samples were hydrated as previously. Mounted in glycerine-jelly (g-j), in Araldite (Ar), without coloration (w.c.). The stains are designated as follows: Os for the postfixed material, the name of the other stains are written without abbreviation. The experimental data are as follows: *Larix decidua* MILL., experiment No: 1/7-1450, (Toluidine Blue, g-j); *Metasequoia glyptostroboides* HU et CHENG, experiment No: 1/7-1449 (w.c. and Toluidine Blue, g-j); *Biota orientalis* ENDL., experiment No: 1/7-1446 (w.c. and Toluidine Blue, g-j); *Juniperus virginiana* L., experiment No: 1/7-1444 (w.c. and Toluidine Blue, g-j); *Juniperus chinensis* L., experiment No: 1/7-1445 (w.c. and Toluidine Blue, g-j); *Taxus baccata* L. experiment No: 1/7-1361a (w.c., g-j); 1/7-1361b (Toluidine Blue, g-j); 1/7-1361c (Os, g-j); 1/7-1361d (Os, Ar); 1/7-1428 (w.c., g-j); 1/7-1429 (Bismarck Brown, g-j); 1/7-1430 (Methylene Blue, g-j); 1/7-1431 (Toluidine Blue, g-j); 1/7-1432 (Eosin B, g-j); 1/7-1433 (Methyl Violet, g-j); 1/7-1434 (Hematoxylin, g-j); 1/7-1435 (Safranine T, g-j); 1/7-1436 (Chrysoidine, g-j); 1/7-1437 (Azure A, g-j); 1/7-1438 (Aniline Red, g-j); 1/7-1439 (Azure II, g-j); 1/7-1440 (Astrazal Blue, g-j); 1/7-1441 (Bromthymol Blue, g-j); 1/7-1442 (Amaranth, g-j); *Taxus baccata* L. cv. *aurea*, experiment No:1/7-1452 (Toluidine Blue, g-j); *Taxus baccata* L. cv. *compacta* experiment No:1/7-1453 (Toluidine Blue, g-j); *Populus alba* L. experiment No: 1/7-1443 (Toluidine Blue, g-j).

Results

1. Transmission electron microscopical results

For the terminology of the ultrastructural elements of the inaperturate *gymnosperm* pollen grains the publication by DUHOUX (1972) was used.

Taxus baccata L.

1.1. Ultrastructure after X-ray irradiation (Plate 10.1., figs. 1,2)

The ultrastructure of the protoplasm is degraded. At the specimen illustrated in Plate 10.1. remnants of the middle layer of the intine (Ie2) were observed. At other pollen grain the Ie2 layer is enclosed within the Ie3 layer (Plate 10.1., fig. 2). Strong degradation was observed at the ectexine and endexine (Plate 10.2., fig. 1), but the originally lamellar ultrastructure of the intine is more or less perceptible.

1.2. Ultrastructure of the hydrated pollen grain (Plate 10.2., figs. 2-6, plate 10.3., figs. 1,2)

The exine ultrastructure after hydratation is similar to those of the irradiated ones (Plate 10.2., fig. 2). A general survey picture illustrated the empty pollen grain (Plate 10.2., fig. 3). The used long hydratation resulted in desintegrated protoplasm (Plate 10.2., figs. 4-6). The preservation of the ultrastructure of the intine is different, but the outest layer (Ie3) and sometimes the exine is well shown, e.g.: Plate 10.3., fig. 1. Ie2 is well illustrated in picture 1, Plate 10.3. Similarly the characteristic lamellar inner layer around the protoplasm (Plate 10.3., figs. 1,2).

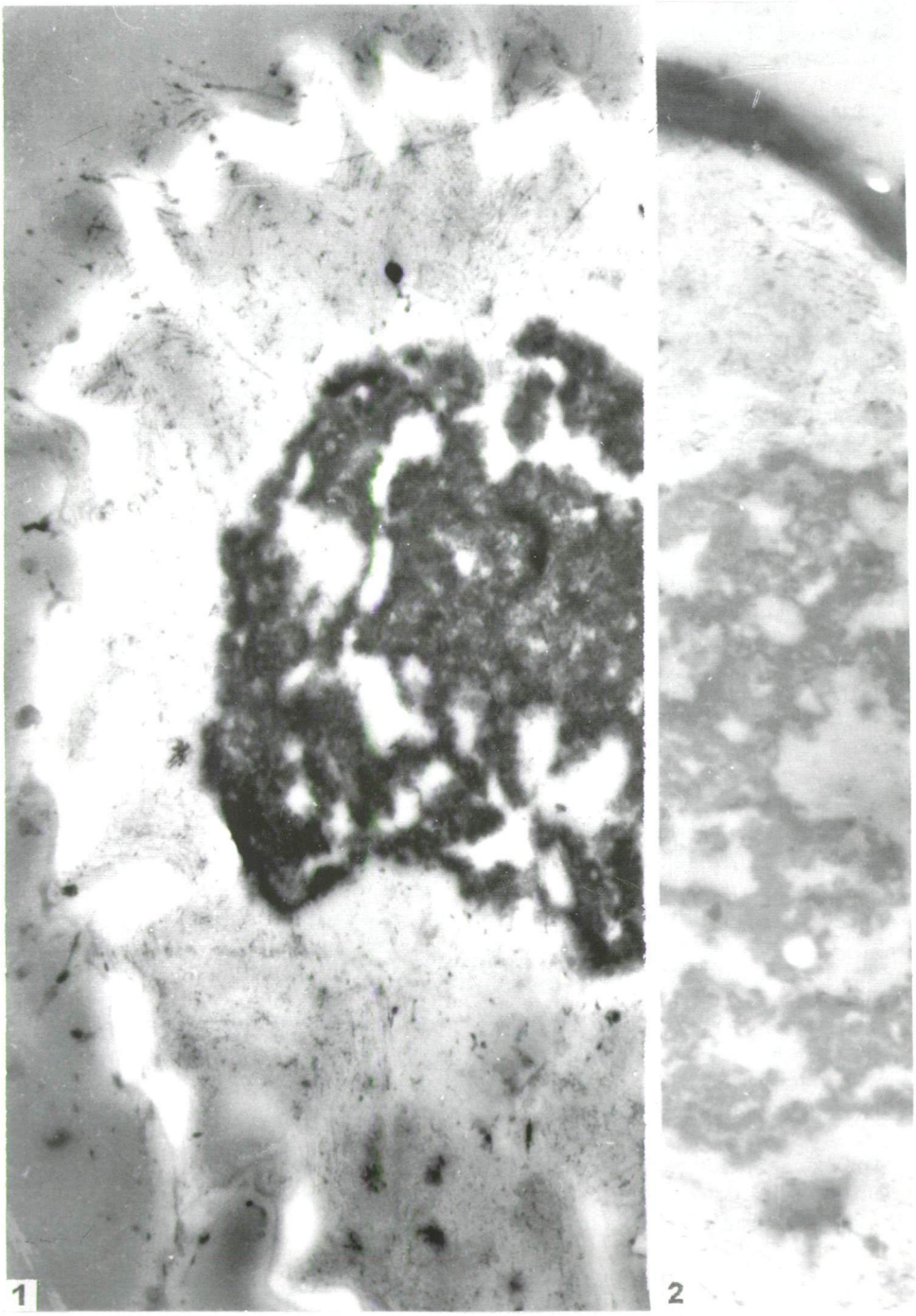

Plate 10.1.

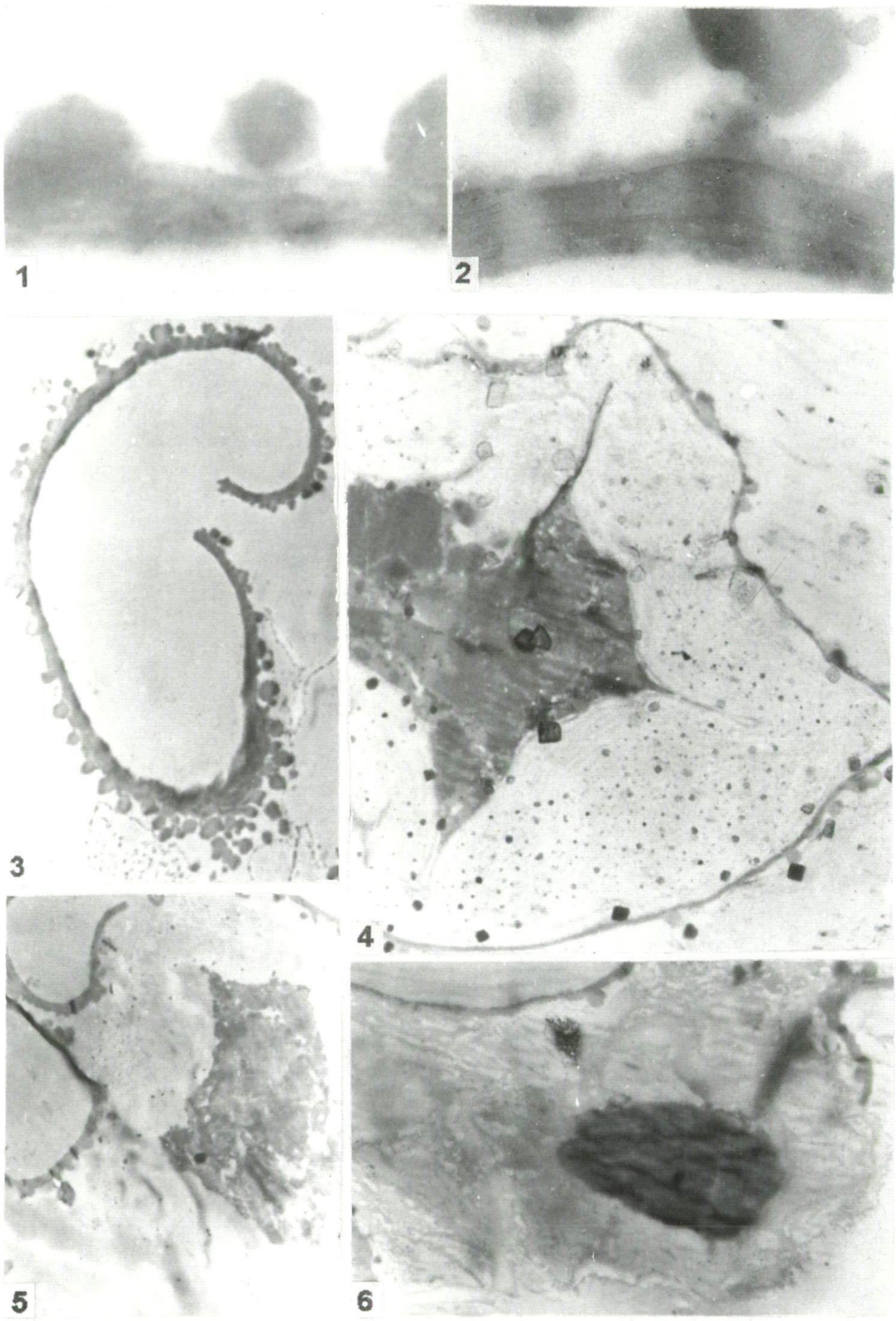

Plate 10.2.

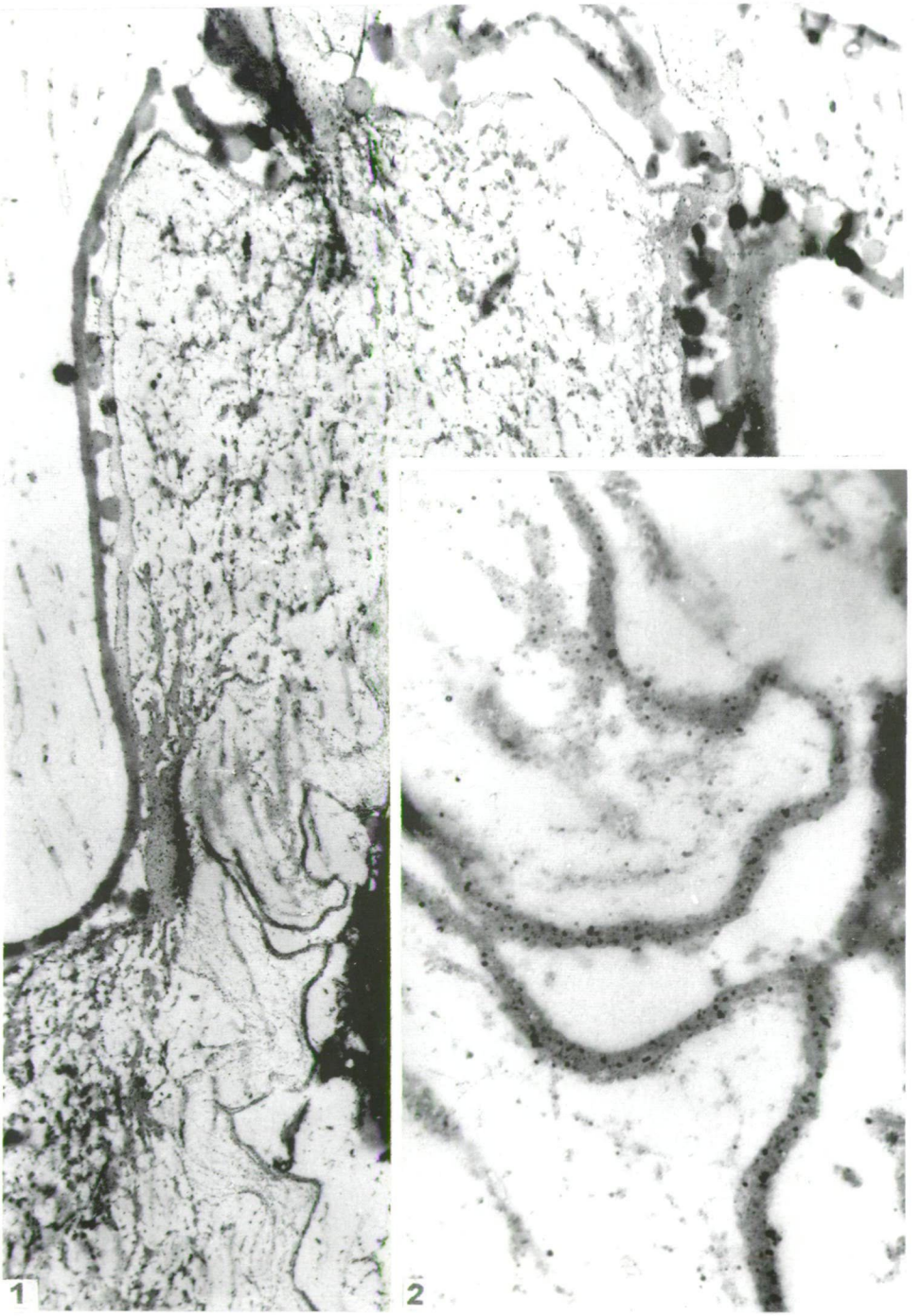

Plate 10.3.

2. Light microscopical results

2.1. *Larix decidua* MILL. (Plate 10.4., figs. 1-4)

No opened pollen grains were observed after hydratation. The thickness of the intine from 5 µm until 22.5 µm, maximum 34% at 10 µm. Average: 11.5 µm. Nucleolus and nucleus were also observed at the hydrated pollen grains (Plate 10.4., figs 1,4).

Remark. - During our previous investigations on partially dissolved pollen grains of *Larix decidua* in several cases the Duhoux effect was observed (KEDVES et al., 1998).

2.2. *Metasequoia glyptostroboides* HU et CHENG (Plate 10.4., figs. 5-11)

The characteristic ligula and the hiatus form was observed in our investigation material (Plate 10.4., figs. 5-7, resp. 8,9). The thickness of the intine was measured at "not opened" pollen grains, so-called dubius form. The thickness of the intine from 2.5 µm until 7.5 µm, maximum 53.0% at 5.0 µm. Average: 5.15 µm.

2.3. *Biota orientalis* ENDL. (Plate 10.4., figs. 12-16)

The hydratation resulted in all kind of secondary forms. In the intine of the pollen grains without exine different kinds of structures (granular, radially oriented fibrillar, network-like) were observed. The thickness of the intine of the "not opened" pollen grains from 5 µm until 10 µm, maximum 42.0% at 7.5 µm. Average: 7.1 µm. The thickness of the intine of the pollen grains without exine from 7.5 µm until 17.5 µm, maximum 26.5% at 12.5 µm. Average: 11.5 µm.

2.4. *Juniperus virginiana* L. (Plate 10.4., figs. 16-21, plate 10.5., figs. 1-3)

Similarly to the previous species all kinds of secondary forms appeared after hydratation. Mostly granular, rarely fibrillar structures are in the intine. The thickness of the intine of the "not opened" forms from 3.75 µm until 7.5 µm, maximum 57.0 % at 5.0 µm. Average: 5,1 µm. The thickness of the intine of the pollen grains without exine from 5.0 µm until 16.25 µm, maximum 24.0% at 10 µm. Average: 10.25 µm.

2.5. *Juniperus chinensis* L. (Plate 10.5., figs. 4,5)

All kinds of secondary froms were observed. Around the protoplasm in the inner half of the intine radially oriented fibrillar or granular differentiations were observed. The thickness of the intine of the "not opened" forms from 3.75 µm until 7.5 µm, maximum 48.5% at 5.0 µm. Average: 5.63 µm. The thickness of the pollen grains without exine from 5.0 µm until 15.0 µm, maxima 25.0% and 25.5 % at 7.5 µm and 10.0 µm. Average: 8.6 µm.

Plate 10.1.

1,2. *Taxus baccata* L. Ultrastructure of the X-ray irradiated pollen grain. Experiment No: 1/7-1744, 1. 10.000x, Negative No: 6240, 2. 25.000x, negative No: 6245.

Plate 10.2.

1-6. *Taxus baccata* L.

1. Ultrastructure of the X-ray irradiated ectexine. Experiment No: 1/7-1744, 50.000x, negative No: 6254.

2-6. Ultrastructure of the hydrated pollen grains. Experiment No: 1/7-361. 2. Detail of the ectexine, 50.000x, negative No: 7267, 3. General survey picture of the empty pollen grain, 5.000x, negative No: 7267, 4-6. Protoplasm, intine and inner part of the endexine, 5.000x, negative numbers: 4. 7261, 5. 7268, 6. 7232.

Plate 10.3.

1,2. *Taxus baccata* L. Ultrastructure of the hydrated pollen grain. Experiment No: 1/7-1761. 1. 10.000x, negative No: 7027, 2. 50.000x, negative No: 7230.

2.6. *Taxus baccata* L. (Plate 10.5., figs. 6-20, plate 10.6., figs. 1-12)

This species was investigated in detail. An attempt was made for revealing the qualitative and quantitative alterations in consequence of the different coloration and/or preparation. Important variations were observed in the morphology of the contracted protoplasm. The different kinds of alterations are illustrated in the above mentioned plates. The qualitative alterations are summarized as follows.

The thickness of the intine of the "not opened" pollen grains

Experiment No	µm from	until	% maximum	µm	µm average
1361/a	2.5	10.0	49.5	7.5	6.7
1361/b	2.5	10.0	47.5	5.0	6.33
1428	3.75	7.5	51.5	5.0	5.28
1429	2.5	8.75	48.5	5.0	5.63
1430	2.5	8.75	44.0	5.0	5.0
1431	3.75	7.5	53.0	5.0	5.44
1432	3.75	7.5	61.5	5.0	5.5
1433	3.75	8.75	48.0	5.0	5.84
1434	3.75	8.75	52.0	5.0	5.65
1435	3.75	8.75	52.0	5.0	5.68
1436	3.75	8.75	49.5	5.0	5.83
1437	5.0	8.75	49.5	5.0	5.84
1438	3.75	7.5	48.0	5.0	5.8
1439	3.75	8.75	55.5	5.0	5.7
1440	2.5	8.75	47.5	5.0	5.75
1441	3.75	8.75	53.0	5.0	5.75
1442	3.75	8.75	57.5	5.0	5.58

The thickness of the intine of the pollen grains without exine

Experiment No	µm from	until	% maximum	µm	µm average
1361/a	7.5	15.0	39.0	10.0	10.8
1361/b	5.0	22.5	32.5	12.5	11.95
1428	7.5	20.0	44.0	12.5	12.73
1429	10.0	18.75	39.5	12.5	13.53
1430	8.75	17.5	42.5	12.5	12.45
1431	7.5	18.75	38.0	12.5	13.28
1432	7.5	18.75	40.0	12.5	14.05
1433	7.5	18.75	39.5	12.5	13.0
1434	10.0	20.0	33.0	12.5	13.95
1435	8.75	18.75	42.0	12.5	12.96
1436	7.5	17.5	44.0	12.5	12.4
1437	10.0	20.0	33.0	12.5	14.3
1438	7.5	18.75	45.5	12.5	13.5
1439	7.5	17.5	40.5	12.5	13.13
1440	7.5	18.75	38.0	12.5	13.25
1441	7.5	18.75	42.0	12.5	12.8
1442	7.5	21.25	28.0	15.0	15.05

The differences in the thickness of the swollen intine are sometimes remarkable.

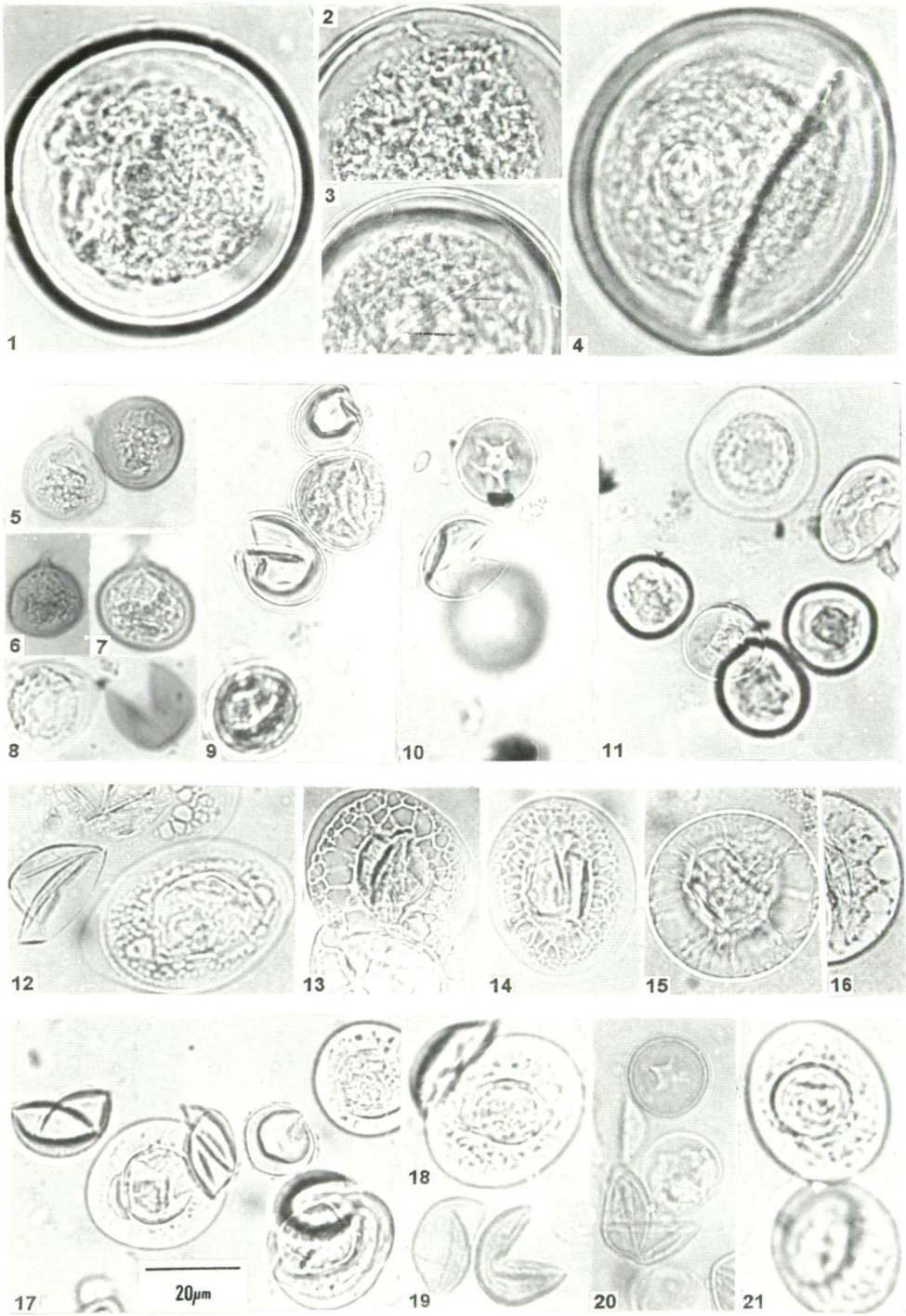

Plate 10.4.

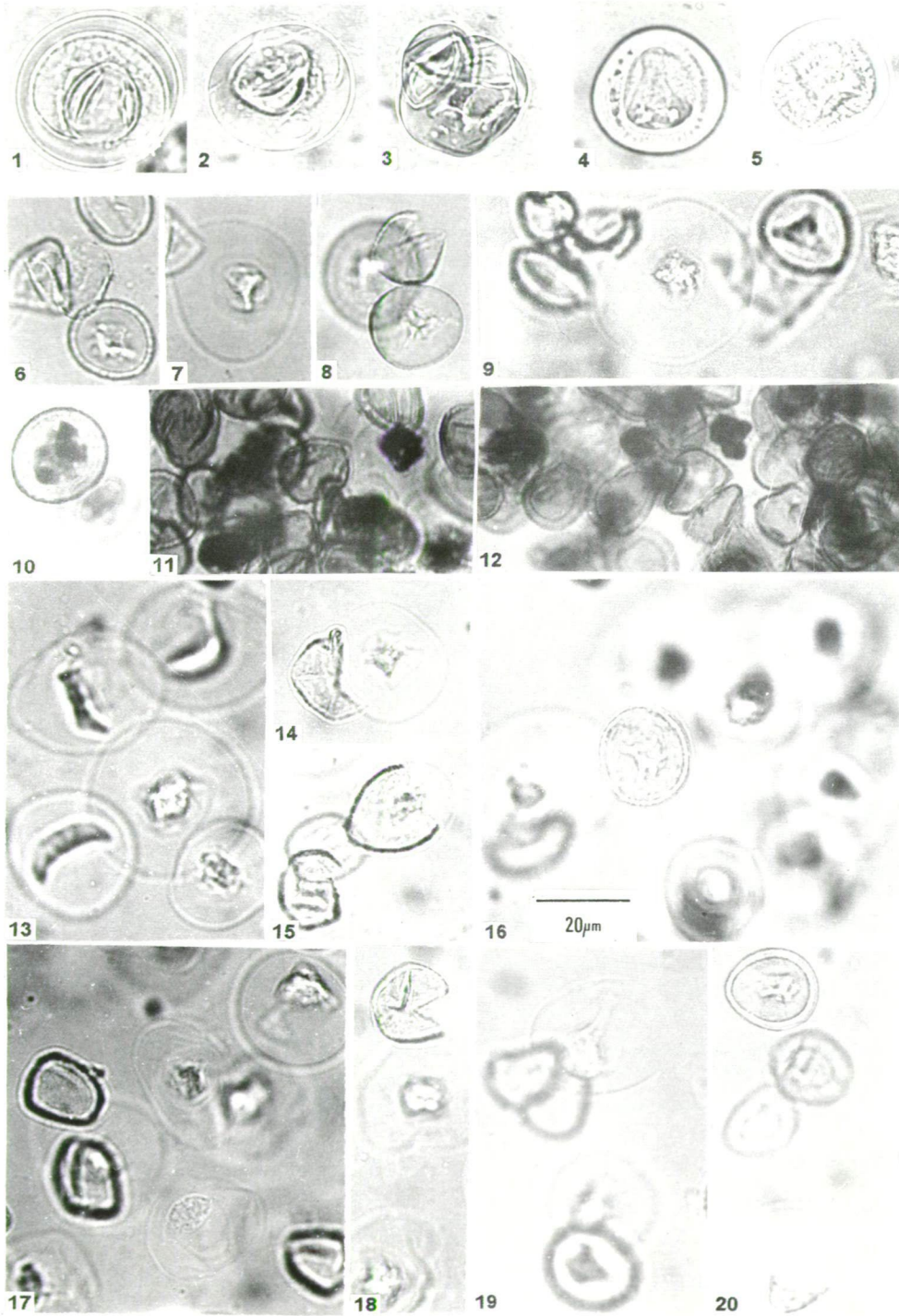

Plate 10.5.

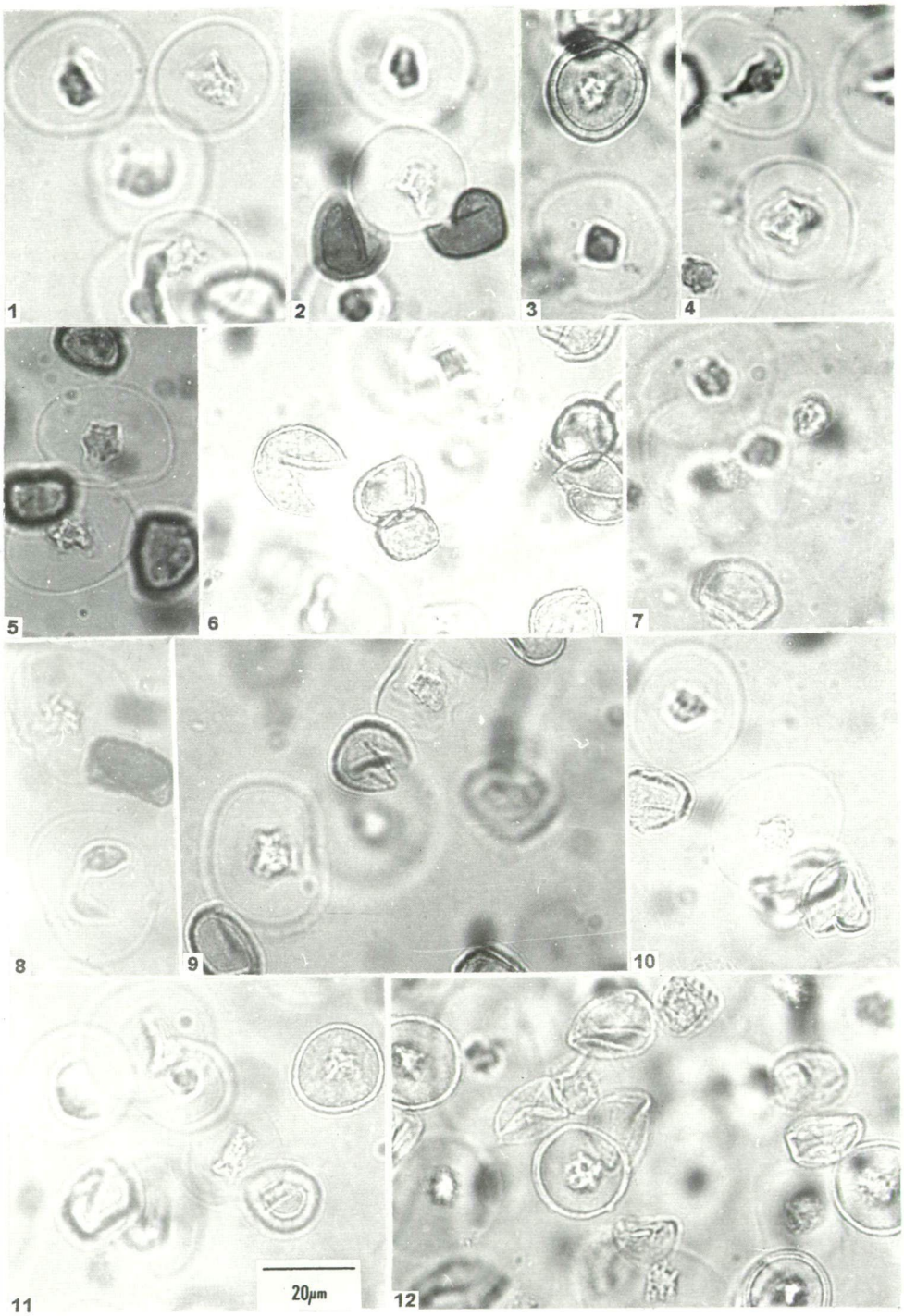

Plate 10.6.

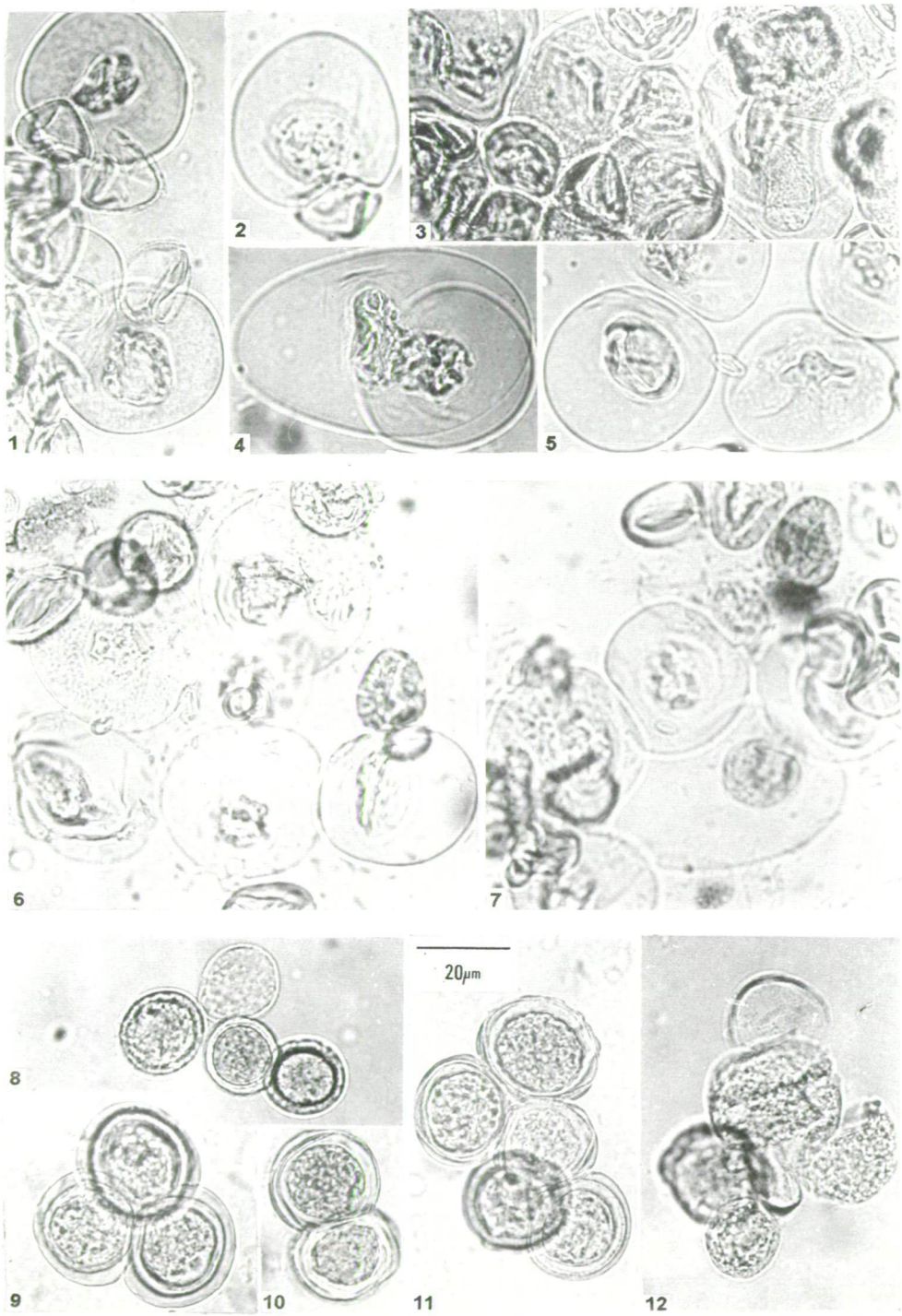

Plate 10.7.

2.7. *Taxus baccata* L. cv. *aurea* (Plate 10.7., figs. 1-5)

All the morphological variations were observed in consequence of the hydratation. The thickness of the intine of the "not opened" forms from 3.75 µm until 10.0 µm, maximum 40% at 5.0 µm. Average: 6.05 µm. The thickness of the pollen grains without exine from 10.0 µm until 26.25 µm, maximum 24% at 15.0 µm. Average: 15.6 µm.

2.8. *Taxus baccata* L. cv. *compacta* (Plate 10.7., figs. 6,7)

The thickness of the intine of the "not opened" forms from 2.5 µm until 10.0 µm, maximum 48.0% at 5.0 µm. Average: 5.65 µm. The thickness of the pollen grains without exine from 10.0 µm until 27.5 µm, maxima 22.5% and 24.0% at 12.5 µm and 15.0 µm. Average:16.5 µm.

2.9. *Populus alba* L. (Plate 10.7., figs. 8-12)

The thickness of the intine of the "not opened" forms from 1.25 µm until 5.0 µm, maximum 56.5% at 2.5 µm. Average: 3.0 µm. The number of the pollen grains without exine was not enough for quantitative evaluations.

Discussion and Conclusions

1. Based on our new results concerning the alterations of the intine ultrastructure we need further experiments, with shorter hydratation at constant temperature and water, after an immediate fixation of the embedding processes. In particular at the hydrated pollen grains of *Taxus baccata* we observed that the desintegration is continuous. A complicated enzymatic and/or microbial effect may also be presumed.

Plate 10.4.

1-4. *Larix decidua* MILL., Experiment No: 1/7-1450.
5-11. *Metasequoia glyprostroboides* HU et CHENG, Experiment No: 1/7-1449.
12-16. *Biota orientalis* ENDL., Experiment No: 1/7-1446.
17-21. *Juniperus virginiana* L., Experiment No: 1/7-1444.

Plate 10.5.

1-3. *Juniperus virginiana* L., Experiment No: 1/7-1444.
4,5. *Juniperus chinensis* L., Experiment No: 1/7-1445.
6-20. *Taxus baccata* L., 6,7. Experiment No: 1/7-1361a; 8,9. Experiment No: 1/7-1361b; 10,11. Experiment No: 1/7-1361c; 12. Experiment No: 1/7-1361d; 13-15. Experiment No: 1/7-1428; 16. Experiment No: 1/7-1429; 17,18. Experiment No: 1/7-1430; 19,20. Experiment No: 1/7-1431.

Plate 10.6.

1-12. *Taxus baccata* L., 1. Experiment No: 1/7-1432; 2. Experiment No: 1/7-1433; 3,4. Experiment No: 1/7-1434; 5. Experiment No: 1/7-1435; 6. Experiment No: 1/7-1436; 7. Experiment No: 1/7-1437; 8. Experiment No: 1/7-1438; 9. Experiment No: 1/7-1439; 10. Experiment No: 1/7-1440; 11. Experiment No: 1/7-1441; 12. Experiment No: 1/7-1442.

Plate 10.7.

1-5. *Taxus baccata* L. cv. *aurea*, Experiment No: 1/7-1452.
6,7. *Taxus baccata* L. cv. *compacta*, Experiment No: 1/7-1453.
8-12. *Populus alba* L., Experiment No: 1/7-1443.

2. To this it is interesting, that the relatively resistant exine altered in the same way after the X-ray and the hydratation effect. But it is also worth of mentioning that during the previous experiments with the *Helix*-enzyme method, the control material was infected by microorganisms, and this microbially degraded exine ultrastructure is similar to those in our present results (KEDVES, 1987, p. 50, Plate I, fig. 1).

3. Our LM results revealed several new data, e.g.: the different form of the contracted protoplasm in consequence of the different colouring at the pollen grains of *Taxus baccata.*

4. In the swolled intine different kinds of structures were observed, which may be pro parte originate from the protoplasm.

5. We hope that our qualitative and quantitative data will be a useful basis for comparison of the further experimental studies.

Acknowledgements

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11. LM INVESTIGATIONS ON PARTIALLY DISSOLVED SPOROMORPHS IV.

M. KEDVES and Á. KÁROSSY

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

Five species from the genus *Encephalartos* (*E. ferox* BERTOL., *E. horridus* LEHM., *E. lehmannii* ECKLON, *E. longifolius* (JACQ.) LEHM., *E. transvenosus* STAPF. et DAVY) were investigated with the partial dissolution method. We established that the molecular system of the sporopollenin of the ectexine of these pollen grains is resistant against the used organic solvents. In contrast to the previous results it is unusual, that the merkaptoethanol altered in an important measure the basic morphology of these originally monosulcate pollen grains. Some of the secondary altered pollen grains are similar to ancient *Normapolles* taxa (*Interpollis*), other ones to evolved *Postnormapolles* (*Alnus* type) of the *angiosperms*.

Key words: Palynology, recent *Encephalartos*, partial dissolution, LM method.

Introduction

During our previous investigations morphologically and taxonomically different kinds of pollen grains were the subjects of partial dissolution. As a terminal part of the research program of the OTKA 1/7 T 14692 five species of one genus were chosen from the genus *Encephalartos*. In this case the morphological characteristic feature was the same, *monosulcate* type what is important in the evolution of the *angiosperm* pollen grains (cf. DOYLE, 1977). The distribution of the recent species of the genus *Encephalartos* is Central and South Africa (SCHUSTER, 1931, GREGUSS, 1968).

ERDTMAN (1954) published the LM morphology of *E. altensteinii* and he wrote as follows; p. 130: "distal part of grain with open furrow". In 1965 ERDTMAN summarized the previous papers concerning the pollen morphology of the genus *Encephalartos*. Besides this work, the earliest paper was published by SMITH (1907).

The basic LM morphology with the intraspecific morphological variations was published by KEDVES and AILER (1990) and a peculiar polar differentiation was described. The *trichotomosulcate* form was occasionally observed at the pollen grains of *E. humilis* VERDOORN. The high temperature effect on the pollen grains of *E. transvenosus* STAPF. et DAVY was investigated in this paper. The first partial dissolution experiments were published by KEDVES and GÁSPÁR (1994) on the pollen grains of *E. ferox* BERTOL. The alterations in consequence of the merkaptoethanol were also observed at these first experiments. Recently the Duhoux effect was investigated on the pollen grains of six species of the genus *Encephalartos*, and of *Ceratozamia mexicana* (KEDVES et al., 1999).

Materials and Methods

Pollen samples of several species of the genus *Encephalartos* were disposed for our investigations by Dr. P. VORSTER (Department of Botany, The University of Stellenbosch, Rep. of South Africa). The method of investigations was our standard method, which was first published in 1997 (KEDVES, KÁROSSY and BORBOLA).

Results

As a general establishment, the resistance of the molecular system of the sporopollenin of the ectexine may be pointed out. The resistance against the diethylamine solvent is worth of mentioning.

But the LM morphological alteration in consequence of the merkaptoethanol may be pointed out. The polar circular differentiation of the exine was observed at all of the experiments. Regarding the details the following will be pointed out.

Encephalartos ferox BERTOL. (Plate 11.1., figs. 1-42)

Diethylamine and methanol have not altered the basic morphology of the pollen grains only after 330 days of dissolution the outer layers of the ectexine detached at the poles. The morphological characteristic features altered in an important measure with the dissolution with merkaptoethanol. The polar separation of the outer layers of the ectexine is characteristic after 30 and 90 days of dissolution. From 150 days the basic monosulcate morphology is not discernible. No important alterations were observed after partial dissolution with ethanol and n-propanol. Minor more or less similar alterations were observed after the dissolution with n-butanol and i-amyl alcohol. There are polar separations of the outer layer of the ectexine and the secondarily rounded ambitus.

Encephalartos horridus LEHM. (Plate 11.2., figs. 1-42)

The characteristic annular differentiation on the proximal surface is more characteristic after dissolution with diethylamine. Merkaptoethanol resulted in very important morphological alterations after 30 days of dissolution. Extremely early extinct *angiosperm* pollen like forms (*Interpollis*) are illustrated in picture 37 (Plate 11.2.). The alterations which appeared in consequence of further alcohol are not characteristics.

Encephalartos lehmannii ECKLON (Plate 11.3., figs. 1-42)

At this species also the dissolution with merkaptoethanol resulted in important alterations. The secondary forms are different from the previous one. The ambitus of the altered forms is quadrangular or pentagonal. In this way the original morphological characteristic features may not be discernible at these pollen grains. The other used solvents resulted in only minor alterations, which were discussed previously.

Encephalartos longifolius (JACQ.) LEHM. (Plate 11.4., figs. 1-42)

The morphological alterations of the partially dissolved pollen grains of this species are nearly identical to those of the previous species. Differences: After 30 days of dissolution the monosulcate forms are characteristic. "*Alnus*-like" morphology appeared after 150 days of dissolution (Plate 11,4., fig. 16).

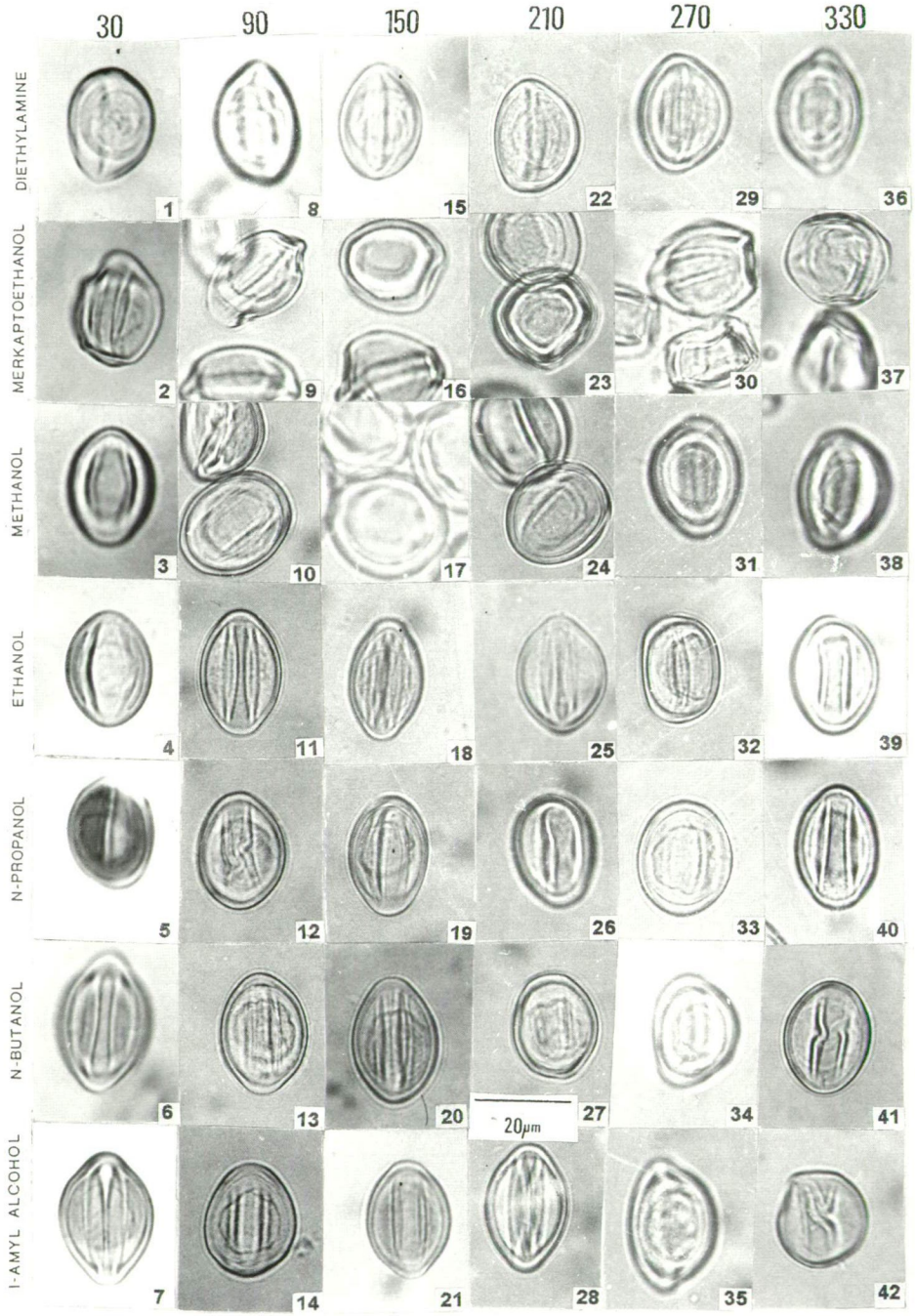

Plate 11.1., 1-42. *Encephalartos ferox* BERTOL.

Plate 11.2., 1-42. *Encephalartos horridus* LEHM.

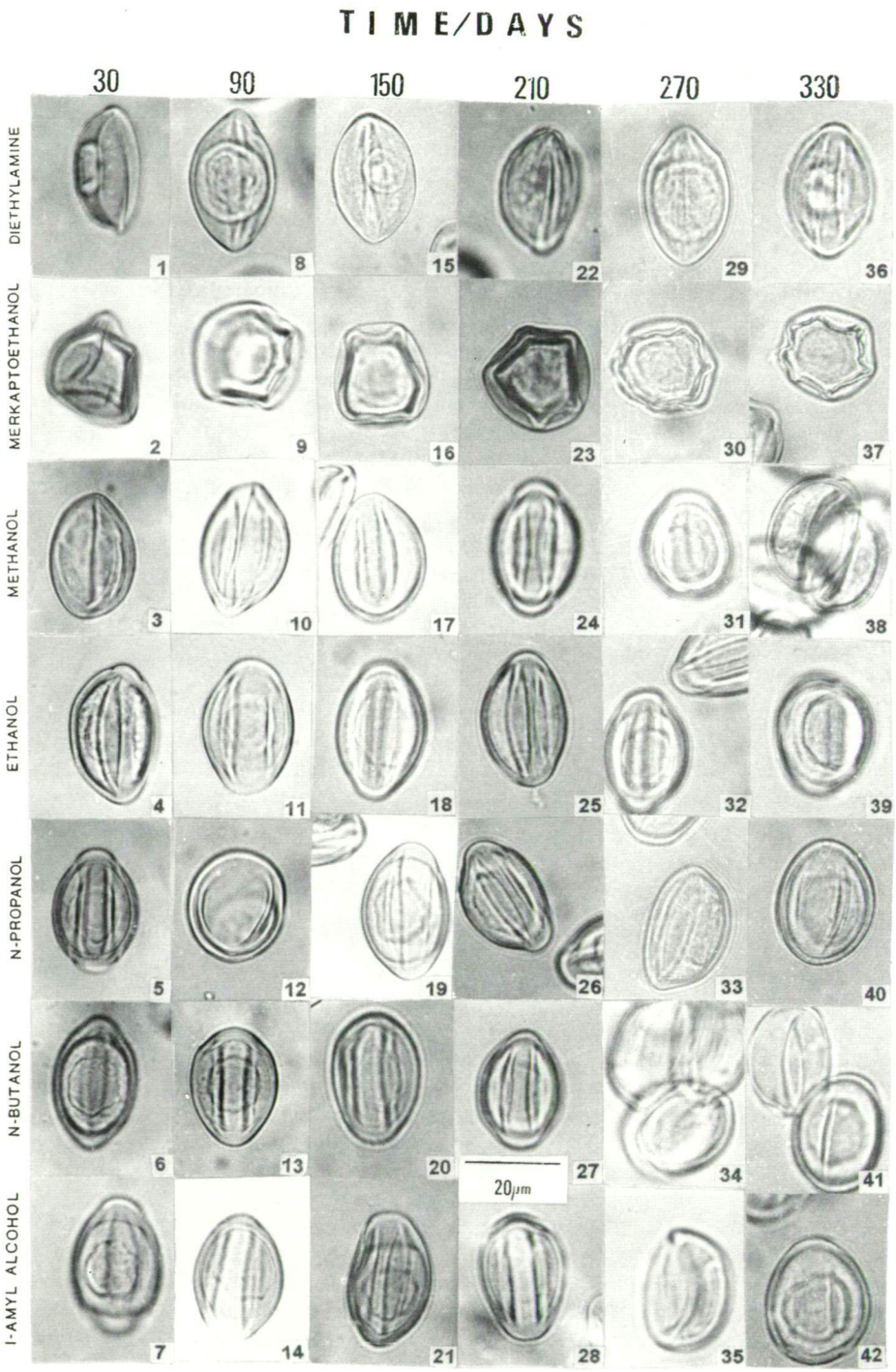

Plate 11.3., 1-42. *Encephalartos lehmannii* ECKLON.

Encephalartos transvenosus STAPF. et DAVY (Plate 11.5., figs. 1-42)

The dissolution's effect of the merkaptoethanol is similar to the previous species. Worth of mentioning alterations in contrast to the previous are as follows: Characteristic alterations after 330 days of dissolution with methanol. At this species the i-amyl alcohol resulted also in taxonomically important alterations after 210-330 days of dissolution.

Discussion and Conclusions

1. The molecular system of the sporopollenin of the investigated *Encephalartos* pollen grains is resistant to the organic solvents, which were used during our experiments. In the first place the resistance against diethylamine may be pointed out.

2. The secondary forms which appeared after the partial dissolution with merkaptoethanol are unusual and important. The secondary forms may be similar to extinct and recent brevaxonate *angiosperm* pollen grains. Differences in the altered forms of the different species investigated were established.

3. It is also interesting that further alcohol resulted in not so important alterations in contrast to the previously investigated angiosperm pollen grains, for example alterations of the *Betula verrucosa* EHR., *Carya illinoensis* (WANG) KOCH (KEDVES, KÁROSSY and BORBOLA, 1997).

Finally further transmission electronmicroscopic investigations of the partially dissolved pollen grains seem to be necessary.

Acknowledgements

Dr. P. VORSTER (Department of Botany, The University of Stellenbosch, Rep. of South Africa was kind to send pollen material for our investigation. We express our sincerest thanks for his kind help. This experimental work was supported by Grant OTKA 1/7 T 14692. Thanks due to Miss M. MADARÁSZ for her valuable assistance in the preparation of the text.

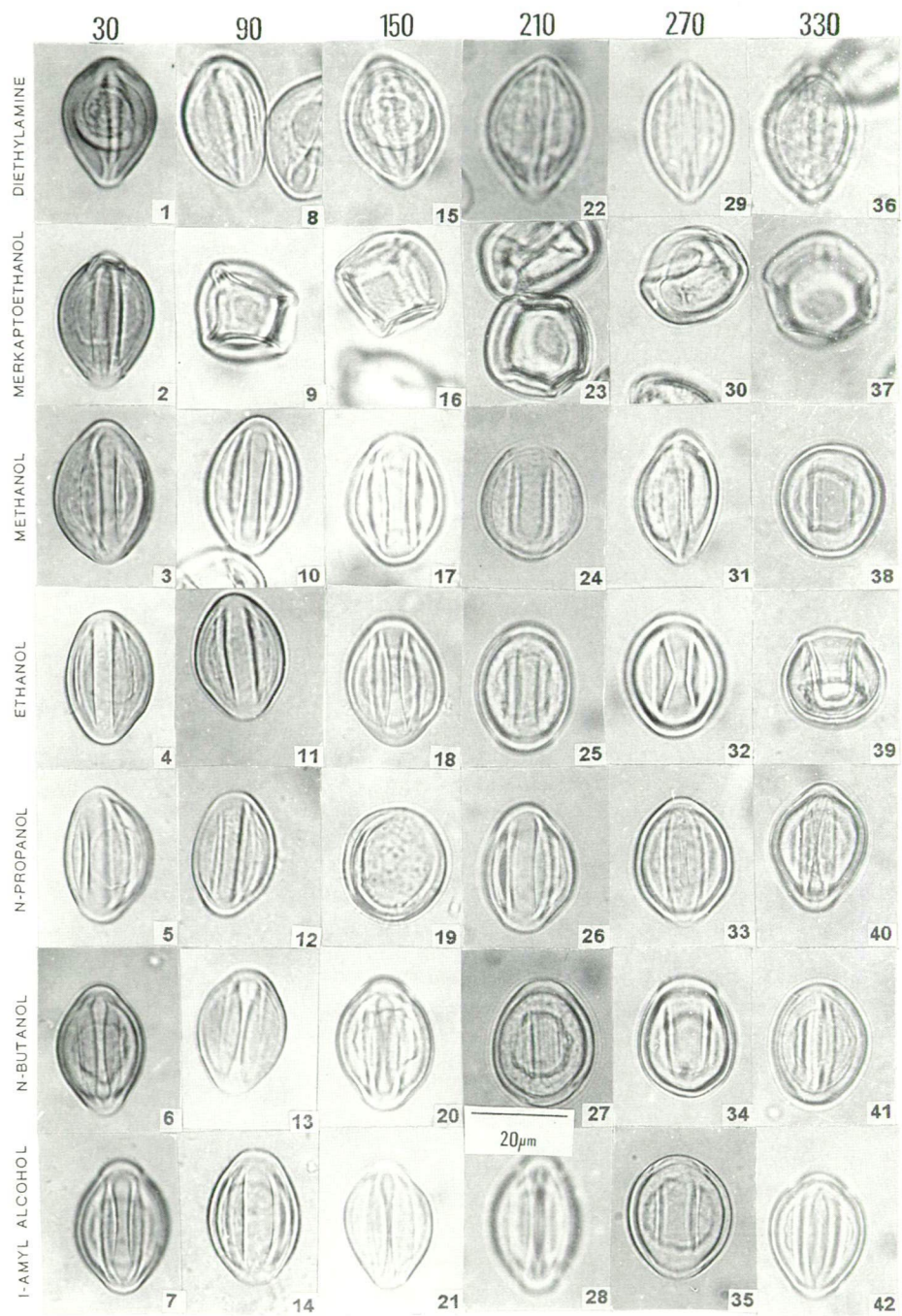

Plate 11.4., 1-42. *Encephalartos longifolius* (JACQ.) LEHM.

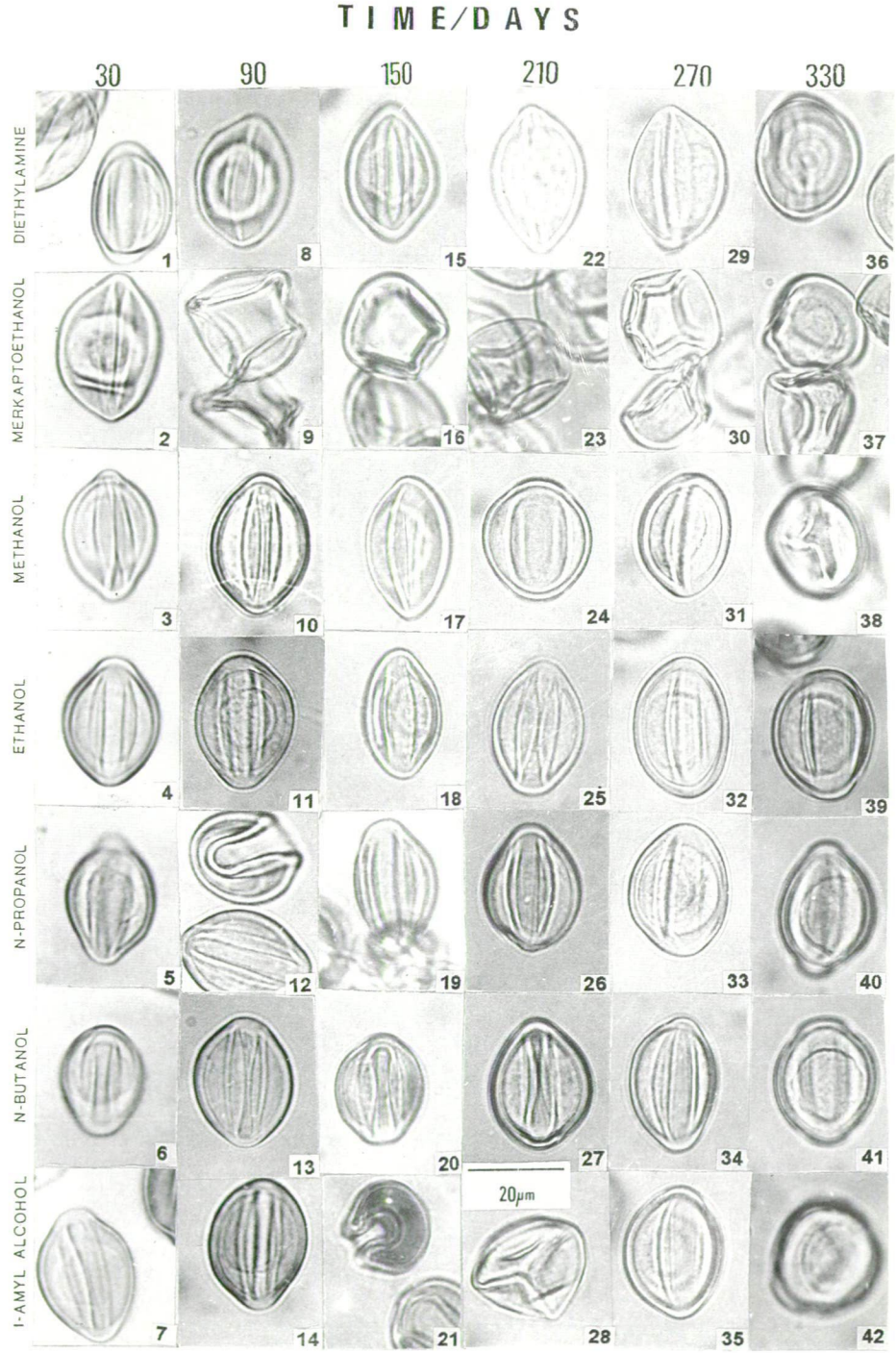

Plate 11.5., 1-42. *Encephalartos transvenosus* STAPF et DAVY.

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12. LM AND TEM INVESTIGATIONS OF PARTIALLY DISSOLVED AND DEGRADED POLLEN GRAINS OF ELAEAGNUS ANGUSTIFOLIA L.

M. KEDVES and ERIKA HORVÁTH

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

Partially dissolved pollen grains with 8 organic solvents were investigated with light microscope. Dissolution with diethylamine resulted in extremely altered pollen forms.

Based on the TEM data of the partial degradation with the 2-aminoethanol and further agents method, it resulted that the sporopollenin of *Elaeagnus angustifolia* is less resistant against degradation.

The 2-aminoethanol degraded the ultrastructure of the exine of the pollen grain. A similar extremely soluble sporopollenin was observed previously at the exospore of *Equisetum arvense* and at the exine of the genus *Quercus, Tilia*, and *Platanus*.

Key words: Experimental Palynology, *Elaeagnus angustifolia.*

Introduction

In a previous paper (KEDVES and PÁRDUTZ, 1982) the importance of the pollen grains of the genus *Elaeagnus* and its fossil forms was discussed. Our studies were carried out on two kinds of maturity of the pollen grains with different methods. LM, TEM and SEM methods were used, and the alterations in the slides, the Cushing effect was also investigated. The interesting ultrastructure of the foot layer in the apertural area and in general the ancient morphological characteristic features of this kind of pollen grains were the reason for the partial degradation of this pollen grains.

The aim of the first researches was to get information about the resistance of the sporopollenin of the pollen grains of *Elaeagnus angustifolia*, and to have TEM data for the partially degraded or dissolved pollen grains.

Materials and Methods

The pollen grains were collected by Miss Vanda KECSKEMÉTI on the 5th May 1997 in the Park of the Alsóváros Church in Szeged. Length of time of all experiments: 30 days at temperature of 30 °C.

Experiment No: 1/7-911. - 20 mg stamen + 5 ml distilled water + 0.2 ml diethylamine.

Experiment No: 1/7-912. - 20 mg stamen + 5 ml distilled water + 0.2 ml merkaptoethanol.

Experiment No: 1/7-913. - 20 mg stamen + 5 ml methanol.

Experiment No: 1/7-914. - 20 mg stamen + 5 ml ethanol.

Experiment No: 1/7-915. - 20 mg stamen + 5 ml n-propanol.

Experiment No: 1/7-916. - 20 mg stamen + 5 ml n-butanol.

Experiment No: 1/7-917. - 20 mg stamen + 5 ml i-amyl alcohol.

Experiment No: 1/7-918. - 20 mg stamen + 5 ml glycerine, 50%.

The dissolution experiments started on 9th June. Slides for LM investigations were mounted in glycerine-jelly hydrated of 39.6%.

For transmission electronmicroscopic investigations the following experiments were carried out:

Experiment No: 1/7-1350. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 24 h.

Experiment No: 1/7-1351. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 48 h.

Experiment No: 1/7-1352. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 72 h.

Experiment No: 1/7-1353. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 24 h + 10 ml $KMnO_4$ 0.01%, temperature 30 °C, length of time 24 h.

Experiment No: 1/7-1354. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 48 h + 10 ml $KMnO_4$ 0.01%, temperature 30 °C, length of time 24 h.

Experiment No: 1/7-1355. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 72 h + 10 ml $KMnO_4$ 0.01%, temperature 30 °C, length of time 24 h.

Experiment No: 1/7-1356. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 24 h + 1 ml merkaptoethanol, temperature 30 °C, length of time 24 h.

Experiment No: 1/7-1357. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 48 h + 1 ml merkaptoethanol, temperature 30 °C, length of time 24 h.

Experiment No: 1/7-1358. - 20 mg stamen + 1 ml 2-aminoethanol, temperature 30 °C, length of time: 72 h + 1 ml merkaptoethanol, temperature 30 °C, length of time 24 h.

After experiment the material was washed, postfixed with OsO_4 aq dil., and embedded in Araldite (Durcupan, Fluka). The ultrathin sections were made on a Porter Blum ultramicrotome in the EM Laboratory of the Institute of Biophysics of the Biological Research Center of the Hungarian Academy of Sciences. The pictures were taken on a Tesla BS-540 (resolution 6-7 Å).

Results

LM results (Plate 12.1., figs. 1-12)

Experiment No: 1/7-911. (Plate 12.1., figs. 1-5). - The diethylamine resulted in extremely altered forms. Most of the pollen grains lost its original morphological characteristic features. Sometimes the originally triangular symmetry altered into sexangular or polyangular. Two opposite triangular forms may be recognized at some altered pollen grains. At other forms (Plate 12.1., fig. 4) the characteristic apertural area may not be recognized, and plicae-like form appeared.

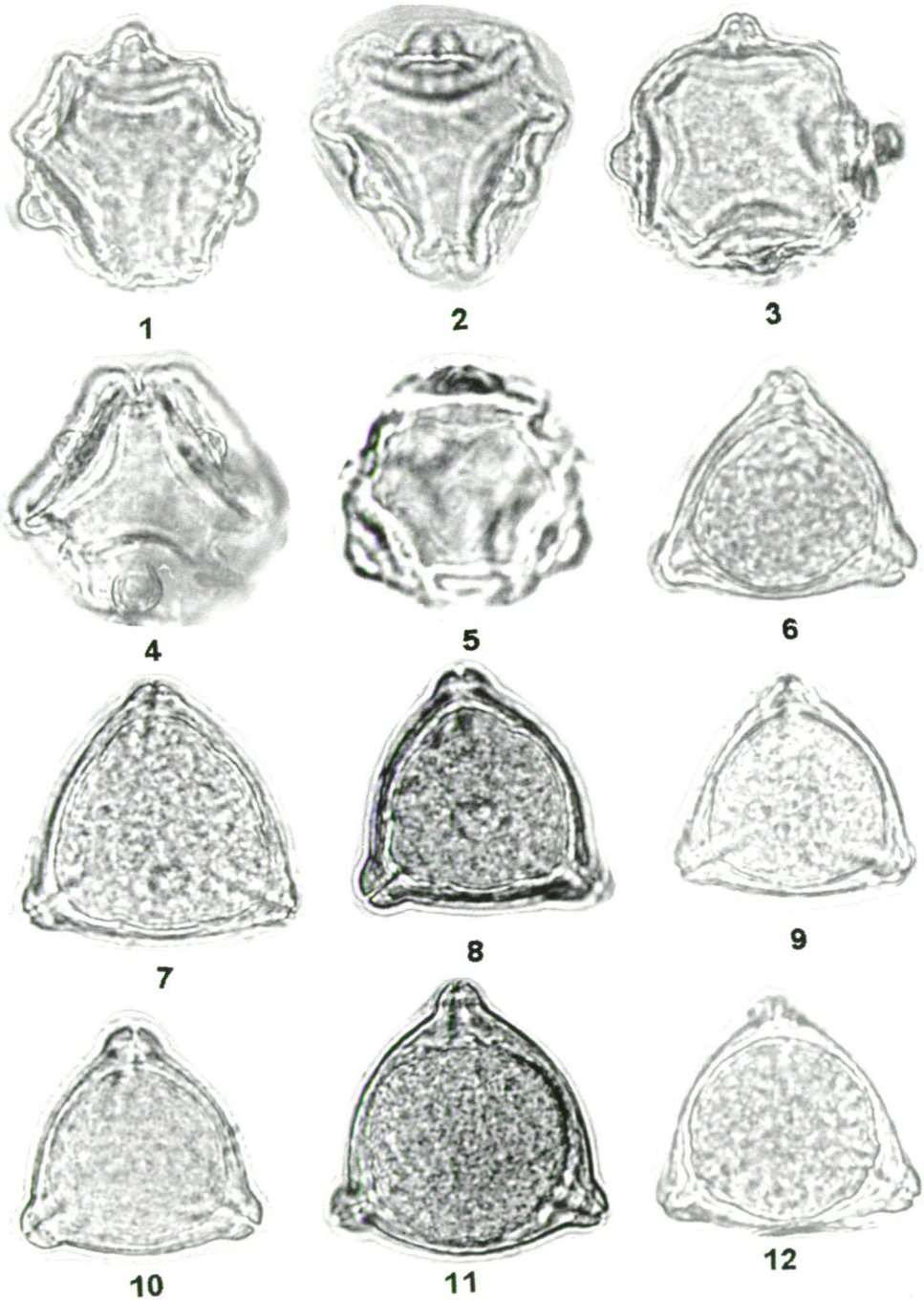

Plate 12.1.

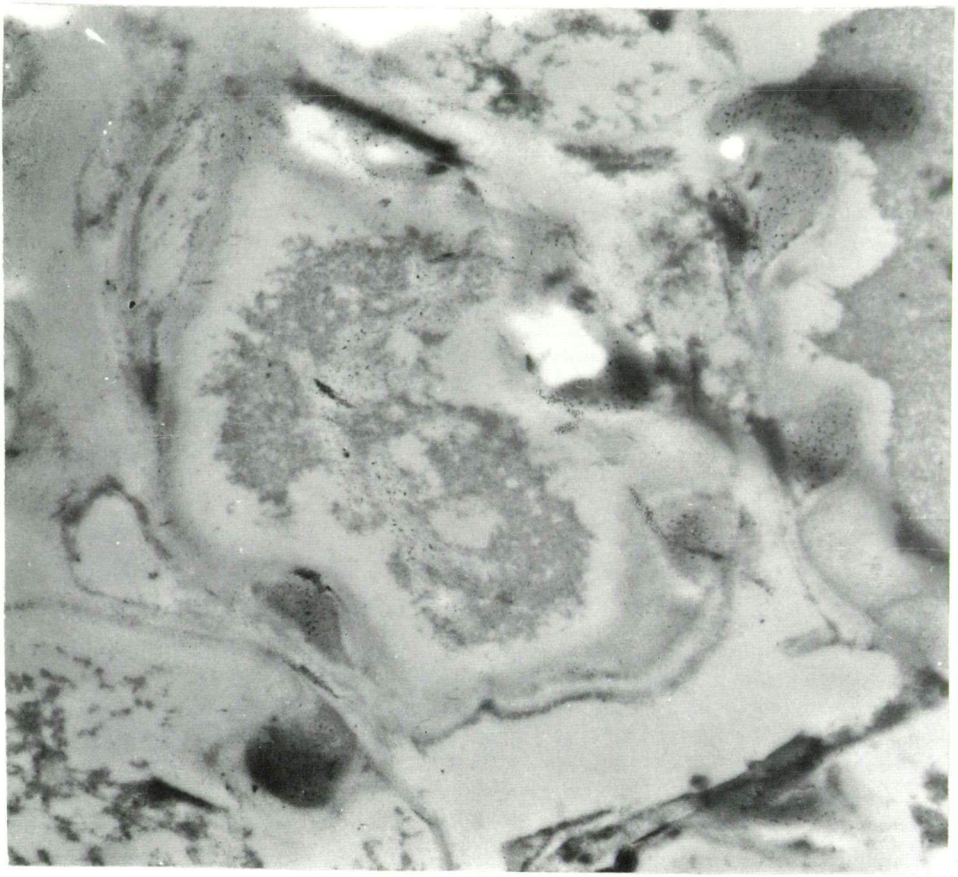

Plate 12.2.

Elaeagnus angustifolia L. TEM picture of partially degraded pollen grains, experiment No: 1/7-1350 Negative No: 7309, 7000x.

← Plate 12.1.

1-12. *Elaeagnus angustifolia* L. 1000x.
1-5. Experiment No: 1/7-911.
6. Experiment No: 1/7-912.
7. Experiment No: 1/7-913.
8. Experiment No: 1/7-914.
9. Experiment No: 1/7-915.
10. Experiment No: 1/7-916.
11. Experiment No: 1/7-917.
12. Experiment No: 1/7-918.

Experiments No: 1/7-912-918. (Plate 12.1., figs. 6-12). - It is well shown in the pictures, that the used alcohols have not altered the basic morphology of the pollen grains. The LM morphology of the protoplasm was not altered in contrast to the pervious experiment.

TEM results (Plate 12.2.)

Experiment No: 1/7-911. We tried to get exine ultrastructural data from the extremely altered pollen grains in consequence of the dissolution with diethylamine. After the investigation of the ultrathin sections of several blocks we have not observed any preserved ultrastructure of the pollen grain.

Experiment No: 1/7-1350. (Plate 12.2.).

It is worth of mentioning, that based on our previous experiments this partial degradation has not displayed the biopolymer system of the ectexine. In this way it is surprising, that the ectexine is extremely degraded. The infratectal layer is more or less completely destroyed. The tectum and the foot layer is a little electron dense. Beneath the remains of the ectexine a darker and a light layer surround the degraded protoplasm. Plasma membrane is not perceptible, but remnants of the nucleus were observed.

Discussion and Conclusions

The partial dissolution with diethylamine resulted in extremely important and interesting secondary forms. This is not so frequent after our experiments. The solubility was also remarkable and a little similar to the previously observed experiments at the exospore of *Equisetum arvense* L. (KEDVES and GÁSPÁR, 1994) and the pollen grains of the genus *Quercus* (KEDVES and GÁSPÁR, 1994, 1996), and *Platanus hybrida* BROT., and *Tilia platyphyllos* SCOP. (KEDVES et al., 1998).

It's interesting that the TEM investigations resulted after the most moderate partial degradation a very degraded ectexine. In general after the partial degradation with 2-aminoethanol the oxydation with $KMnO_4$ aq. dil. was also necessary to discover the biopolymer structure of the ectexine.

Taking into consideration the very interesting morphology to the pollen grains of the genus *Elaeagnus*, and the interesting fine structure of the exine of the non-experimental material, it seems that further experiments are necessary. But in this contribution we present our first experimental attempt, and the first few results.

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13. HIGH TEMPERATURE EFFECT ON MONOLETE FERN SPORES

M. KEDVES, ZS. TERBE, ESZTER HORVÁTH and J. SASHALMI

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

Four species of monolete fern spores were heated during 10s, 1h, 10, 25, 100 and 300 hours. The qualitative and quantitative alterations were investigated by the LM method. The alterations of the diameter of the spores are particular. After short time of heating the size of the spore may diminish or increase. The alterations of the quantitative character may be regular or irregular at the different species investigated.

Key words: Palynology, recent, monolete spores, high temperature effect.

Introduction

During our research program of the secondary alterations of the sporomorphs in consequence of high temperature effect first we investigated *angiosperm* and *gymnosperm* pollen grains (e.g.: KEDVES and KINCSEK 1989, KEDVES, TÓTH and FARKAS, 1991b). At the pollen grains of several *angiosperm* and *gymnosperm* taxa, important alteration were established. Several secondary forms are important from taxonomical and evolutionary points of view. Till this time few spores were investigated in this respect, the investigated species are the following: *Ustilago maydis* (KEDVES and TÓTH, 1993), *Equisetum arvense* (KEDVES, TÓTH and FARKAS, 1991a), microspores of *Selaginella haematodes*, *S. serpens*, micro- and megaspores of *Selaginella inaequalifolia* (KEDVES, 1990).

Till this time the high temperature effect was not investigated on monolete spores. Taking into consideration the importance of the monolete spore forms in the fossil spore-pollen assemblages, and in some cases their peculiar wall structure we carried out such experiments on monolete fern spores. The aim of this paper is to present comparative data to the fossil forms and the previous experimental results on recent species.

Materials and Methods

The investigation material was collected in the Botanical Garden of the J.A. University. The aim of the selection of the species for high temperature effect was that the most important morphological types of the monolete spores be represented. The following species were investigated: *Blechnum occidentale* L. (*Blechnaceae*), *Polypodium crassifolium* L. (*Polypodiaceae*), *Nephrolepis exaltata* SCHOTT (*Oleandraceae*), *Asplenium nidus* L. (*Aspleniaceae*). The taxonomy followed the book of HUANG (1981). Fresh and

heated spores on 200 °C during 10s, lh, 5, 10, 25, and 300 hours were investigated. Experiments numbers: *Blechnum occidentale* L., T9-P-866-870; *Polypodium crassifolium* L., T9-P-846-850; *Nephrolepis exaltata* SCHOTT, T9-P-861-865; *Asplenium nidus* L. T9-P-851-855;

Results

I. Qualitative results (Plate 13.1., figs. 1-21, plate 13.2., figs. 1-10)

1.1. *Blechnum occidentale* L. (Plate 13.1., figs. 1-6)

The exospore of the fresh spores is covered by a thin perispore (Plate 13.1., fig. 1). After heating, 10s, and 1 hour the separation of the perispore started (Plate 13.1., figs. 2,3). After 10 hours the spores are without perispore (Plate 13.1., figs. 4-6). The characteristic bean form became deformed after 300 hours of heating (Plate 13.1., fig. 6).

1.2. *Polypodium crassifolium* L. (Plate 13.1., figs. 7-12)

The characteristic basic verrucate sculpture of the exospore is well shown at the fresh (Plate 13.1., fig. 7) and the heated spore during 10s (Plate 13.1., fig. 8). After 1 hour (Plate 13.1., fig. 9) the elements of the sculpture diminish. After 10 and 25 hours of heating (Plate 13.1., figs. 10,11) the degradation of the ornamental elements is characteristic. Finally after 300 hours of heating (Plate 13.1., fig. 12) the surface is smooth or granular by the remnants of the sculpture. The amb is bean-form as originally, but the exospore is cracked (Plate 13.1., fig. 12).

1.3. *Nephrolepis exaltata* SCHOTT (Plate 13.1., figs. 13-21)

The characteristic verrucate sculpture of the fresh spore (Plate 13.1., fig. 13) has not altered in a remarkable manner in consequence of the temperature. The size of the elements is smaller than originally after 300 hours of heating as well (Plate 13.1., figs. 20,21).

1.4. *Asplenium nidus* L. (Plate 13.2., figs. 1-10)

The perispore of the fresh spores (Plate 13.2., figs. 1,2) is characteristic. After 10s of heating minor alterations were observed only in the spore morphology (Plate 13.2., figs. 3,4). After 1 hour of heating remarkable degradation of the perispore was observed (Plate 13.2., figs. 5,6). After 10 hours of heating remnants of the perispore were only observed (Plate 13.2., fig. 7), and deformations of the characteristic bean form begun. Spores heated 25 and 300 hours (Plate 13.2., figs. 8,9 and 10) are without perispore and with secondarily deformed ambitus.

2. Quantitative results

2.1. Alterations of the equatorial axis

2.1.1. *Blechnum occidentale* L.

	27.5	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5	50.0	52.5	55.0	µm
0		1.5	2.5	0.5	4.0	7.0	24.0	**35.0**	22.5	3.0			%
10s					3.0	3.5	6.5	**20.5**	**20.5**	19.0	16.5	10.5	
1h			1.0	1.5	1.5	5.5	15.5	26.0	**28.0**	12.0	7.0	2.0	
10h	1.5		0.5	3.0	4.5	8.5	**21.5**	20.5	**21.0**	14.5	4.5		
25h			0.5	2.5	10.5	17.5	**25.5**	15.5	16.0	9.5	2.5		
300h			5.5	14.0	**21.0**	18.0	17.5	19.5	1.5	2.0		1.0	

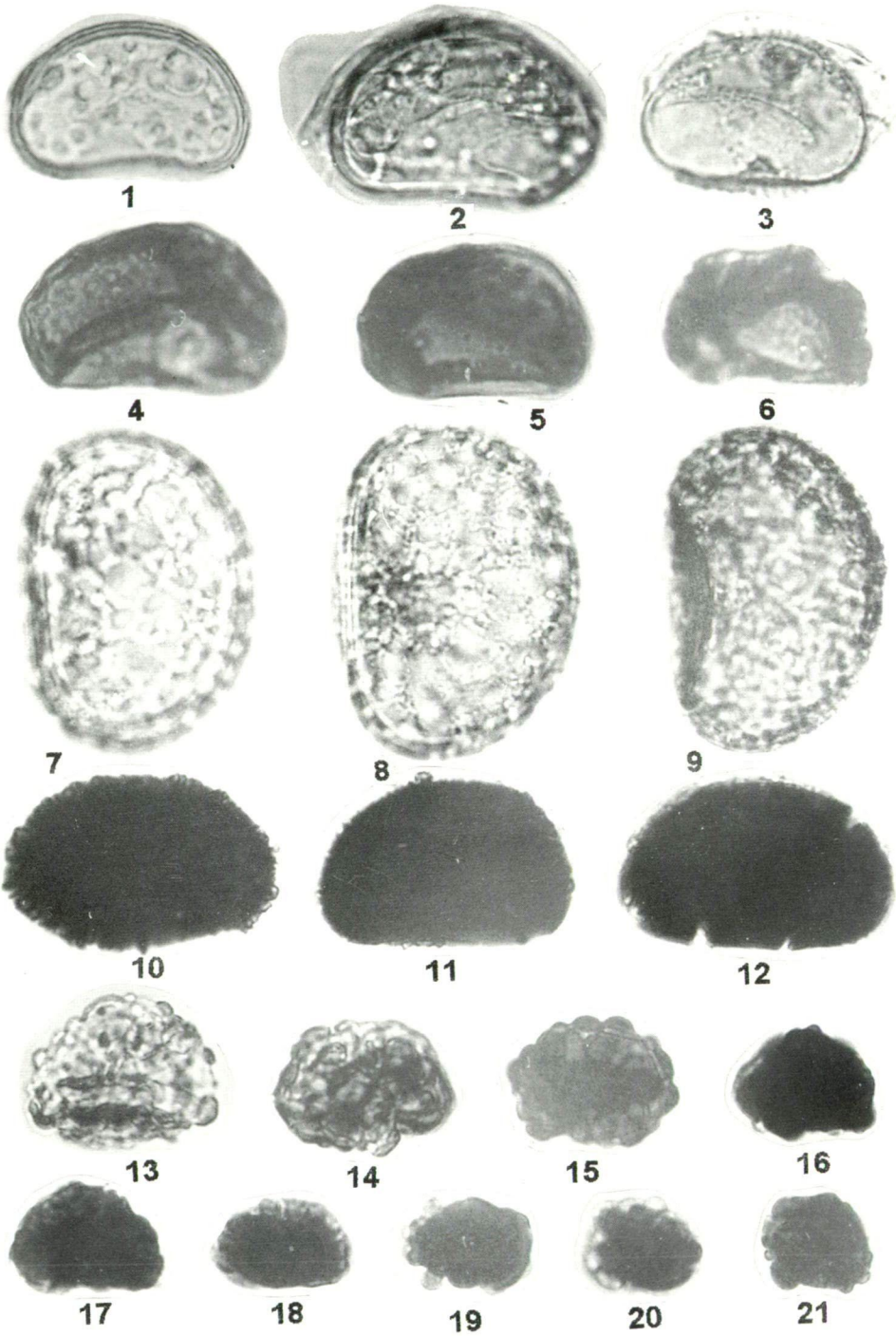

Plate 13.1

After 10s, 1h and 10 hours of heating the size increased in a peculiar manner. After 25 hours of heating the diameter of the spores slightly diminish. Important reduction in the size of the spores appeared after 300 hours.

2.1.2. *Polypodium crassifolium* L.

	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5	50.0	52.5	55.0	57.5	60.0	62.5	65.0	67.5	70.0 µm
0								2.5	9.5	**29.0**	26.0	17.5	6.5	4.5	3.0		1.5 %
10s							3.5	5.5	17.0	20.0	**21.0**	20.5	7.0	4.5		1.0	
1h					1.0	1.5	10.5	21.0	**28.0**	22.0	11.0	4.5		0.5			
10h	0.5		1.0	1.0	8.5	26.5	**29.5**	21.0	11.0	1.0							
25h			2.0	5.5	20.5	**28.5**	22.0	15.5	5.0	0.5	0.5						
300h		1.0	0.5	3.5	11.5	20.0	25.5	**26.0**	10.0	0.5	1.5						

10s heating resulted larger secondary forms. 1 hour, 10 and 25 hours of heating the size diminishes in a remarkable manner, but it is interesting that the longest heating (300 hours) resulted in relatively larger forms.

2.1.3. *Nephrolepis exaltata* SCHOTT

	15.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5	40.0	42.5 µm
0			2.5		6.0	21.0	**31.0**	23.5	12.0	3.5	0.5	%
10s					9.0	16.0	**31.0**	20.0	18.0	6.0		
1h	1.0	2.5	5.5	7.0	**19.0**	**19.0**	17.0	13.5	8.0	7.0		0.5
10h		9.5	6.0	9.5	**24.5**	18.5	13.5	15.0	3.5			
25h			1.5	23.0	**34.0**	17.5	21.5	2.5				
300h	2.0	12.0	**22.0**	21.0	16.5	18.0	6.5		2.0			

The size have not altered essentially after 10s of heating. After longer heating the diameter of the spores diminished. Worth of mentioning is that the maxima of the heating at 1 hour, 10 and 25 hours are the same (25.0 µm). Heating during 300 hours resulted in an important diminution in the size.

2.1.4. *Asplenium nidus* L.

	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5	50.0	52.5	55.0	57.5	60.0	62.5	65.5 µm
0							0.5	1.0	0.5	1.0	9.5	9.0	18.0	**21.5**	20.0	12.5	2.5	3.0	1.0
10s									1.5	3.0	12.5	18.5	**24.5**	17.0	11.5	10.0	0.5	1.0	
1h							4.5	15.5	**25.0**	23.0	19.5	12.5							
10h		2.0	9.0	7.0	15.5	24.0	**24.5**	15.0	2.5	0.5									
25h			7.5	29.0	**29.5**	21.0	7.5	5.5											
300h	1.5	1.5	16.5	25.0	**31.5**	15.0	8.0	1.0											

At this species the diameter of the spore diminishes more or less regularly by the time of heating.

Plate 13.1.

1-6. *Blechnum occidentale* L.
1. Fresh spore; 2. Experiment No: T9-P-866; 3. Experiment No: T9-P-867; 4. Experiment No: T9-P-868; 5. Experiment No: 869; 6. Experiment No: T9-P-870.

7-12. *Polypodium crassifolium* L.
7. Fresh spore; 8. Experiment No: T9-P-846; 9. Experiment No: T9-P-847; 10. Experiment No: T9-P-848; 11. Experiment No: T9-P-849; 12. Experiment No: T9-P-850.

13-21. *Nephrolepis exaltata* SCHOTT
13. Fresh spore; 14. Experiment No: T9-P-861; 15. Experiment No: T9-P-862; 16,17. Experiment No: T9-P-863; 18,19. Experiment No: T9-P-864; 20,21. Experiment No: T9-P-865.

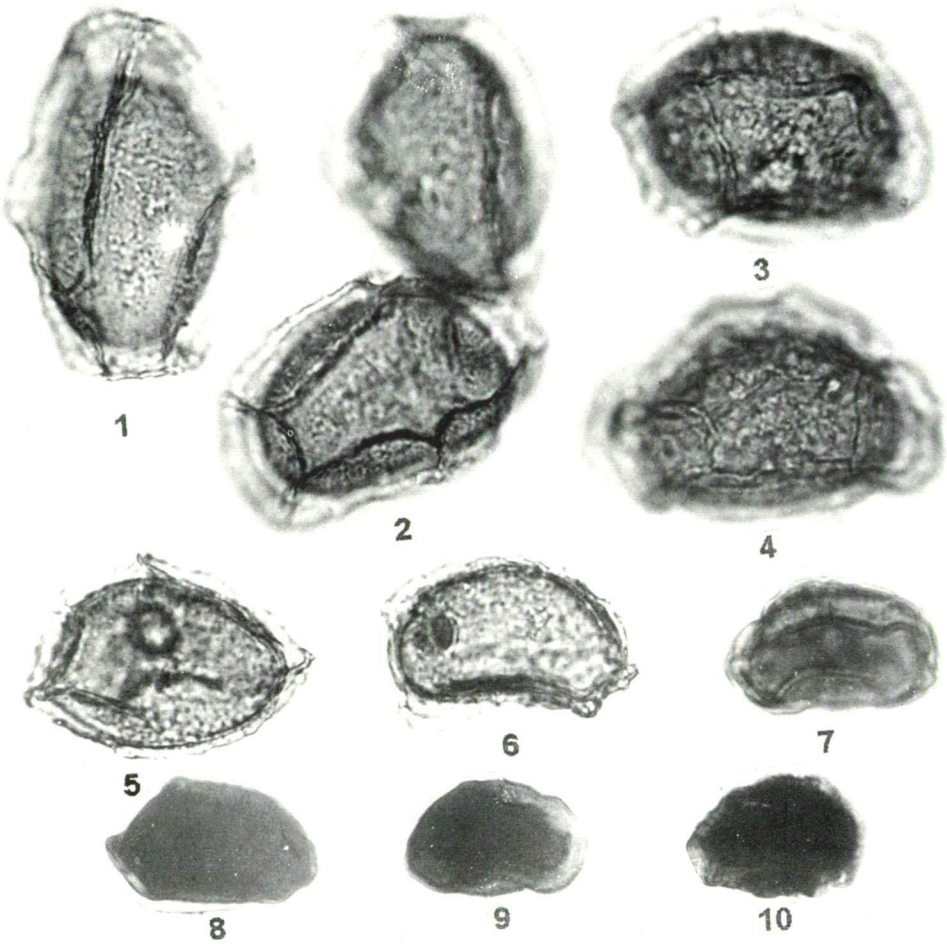

Plate 13.2.

1-10. *Asplenium nidus* L.
1,2. Fresh spores; 3,4. Experiment No: T9-P-851; 5,6. Experiment No: T9-P-852; 7. Experiment No: T9-P-853; 8,9. Experiment No: T9-P-854; 10. Experiment No: T9-P-855.

Discussion and Conclusions

1. At the spores of *Blechnum occidentale* and *Asplenium nidus* after the degradation of the perispore the amb of the monolete spore deformed.

2. The ornamental elements at *Polypodium crassifolium* have been degraded in consequence of high temperature, at the spores of *Nephrolepis exaltata* qualitative changes were not observed.

3. The alterations in the size of the spores based on our up-to-date knowledge are irregular.

4. Such alterations may happen also at the fossil forms in particular at the metamorphic sediments.

Acknowledgements

This work was supported by Grant OTKA T/9 023208.

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14. HIGH TEMPERATURE EFFECT OF THE POLLEN GRAINS OF BUXUS SEMPERVIRENS L.

M. KEDVES, ESZTER HORVÁTH, ZS. TERBE and D. TOMBÁCZ

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

Fresh and heated pollen grains at 200 °C during 1 hour, 5, 10, 25, 50, 100, 200 and 300 hours of *Buxus sempervirens* were investigated with the LM method. The qualitative and quantitative results are presented in this contribution.

Key words: Palynology, recent, *Buxus*, high temperature effect.

Introduction

Our experimental studies on the morphological alterations in consequence of high temperature started in 1989 (KEDVES and KINCSEK) on *Amentiflorae* pollen grains. Important alterations were described at the triaperturate pollen grains (*Corylus* and *Betula*) but no important qualitative alterations were established at the polyporate pollen grains of the genus *Juglans*.

Pollen grains of *Buxus* type occur in the Tertiary spore-pollen assemblages (KRUTZSCH, 1966, POTONIÉ, 1970). Concerning the pollen morphology of the *Buxaceae* there are a number of publications. ERDTMAN (1952) published the following: p. 86: "Pollen grains usually polyforate (diameter about 30-45μ)". "*B. sempervirens* (leg. Osbeck, May 1970): 30μ (sexine possibly provided with vestigial spinules)." VAN CAMPO (1967) pointed out the following: p. 65: "Spheroid pollen grains are considered successiform when the number and the disposition of the apertures vary according to a geometrical succession: the colpi issued from the apex of a same equilateral triangle project in plane on segments with angles of 120°. In the periporate grains, the same law leads to a quincunx order of the pores." KÖHLER (1980) established the trends of aperture and exine evolution of the Neotropical species of the *Buxus* pollen grains. Taking into consideration that the polyporate pollen grains are important in the fossil spore-pollen assemblages it is important to investigate the high temperature effect experimentally on recent species.

The aim of the present contribution is to add experimental data to the knowledge of the isodiametric polyaperturate pollen grains.

Materials and Methods

Pollen grains for our investigations were collected by Miss Zs. TERBE on the 17.04.1999 in Újszeged. The experiments were carried out in the Cell Biological and Evolutionary Micropaleontological Laboratory of the J.A. University as follows: Fresh pollen grains (T9-P-1). Temperature of heating: 200 °C, length of time and numbers of experiments: 1h, T9-P-2; 5h, T9-P-3; 10h, T9-P-4; 25h T9-P-5; 50h, T9-P-6; 100h, T9-P-7; 200h, T9-P-8; 300h, T9-P-9. The pollen grains were mounted in glycerine-jelly hydrated at 39.6%.

Results

1. Qualitative results (Plate 14.1., figs. 1-8, plate 14.2., figs. 1-24)

According to the previous establishments the fresh pollen grains are spheroidal and polyforate (Plate 14.1., figs. 1-8, plate 14.2., figs. 1,2). Surface is finely reticulate (Plate 14.1., figs. 1,2,4,5,7). In optical section (Plate 14.1., figs. 3,6) columellar infratectal layer and intine (Plate 14.1., fig. 3) are well shown. The protrusion (Plate 14.1., figs. 7,8) and the peculiar lamellar, thickened intine in the apertural area (Plate 14.1., fig. 6) were observed. Concerning the heated pollen grains our results may be summarized as follows: 1. After 1h of heating (Plate 14.2., fig. 3) protrusion of the protoplasm was observed. 2. The amb from 5h until 300h of heating altered; tri-, tetra-, penta- and poly-angular secondary forms appeared. 3. Alterations in the apertural area were also observed. The most important is the colpus-like exoaperture (Plate 14.2., fig. 7).

2. Quantitative results

Time of heating	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5	50.0	µm
0			0.5	2.0	2.5	12.5	21.5	**40.0**	16.0	4.0	0.5		0.5	%
1h				1.0	13.0	15.5	20.0	**27.0**	17.0	3.5	2.5	0.5		
5h			4.5	7.5	16.0	**18.0**	**18.0**	13.5	10.0	7.0	4.0	1.5		
10h			2.5	7.5	16.5	18.5	**26.0**	19.0	9.0	0.5	0.5			
25h				9.5	**28.0**	25.5	18.0	15.5	3.5					
50h			3.5	24.5	**34.5**	17.5	10.5	7.0	2.5					
100h	0.5	3.5	**29.5**	26.5	23.5	14.0	2.5							
200h	0.5	13.0	**42.5**	21.5	17.0	5.5								
300h	2.0	15.5	**60.0**	12.0	8.0	2.5								

The maximum value of the diameter of the fresh pollen grains is 40.0% at 37.5 µm. After heating these values vary as follows: 1h: 27.0% at 37.5 µm, 5h: 18.0 at 32.5 and 35.0 µm, 10h: 26.0% at 35.0 µm, 25h: 28.0% at 30.0 µm, 50h: 34.5% at 30.0 µm, 100h: 29.5% at 25.0 µm, 200h: 42.5% at 25.0 µm, 300h: 60.0% at 25.0 µm.

It is worth of mentioning that the maximal values of the diameters of 25 and 50 hours respectively 100, 200, and 300 hours are identical only the percentages increase.

The percentages over 10% regularly diminish.

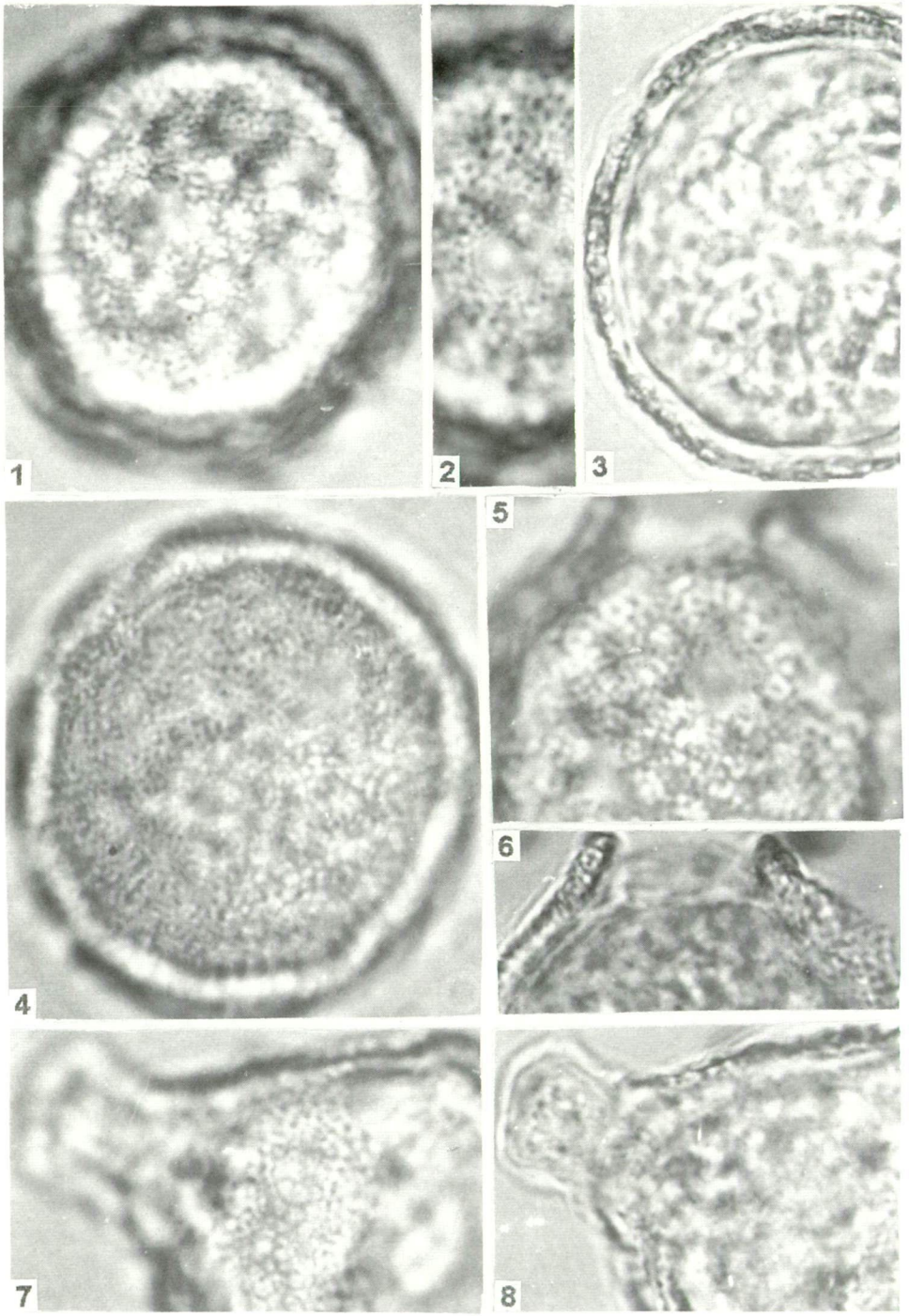

Plate 14.1.

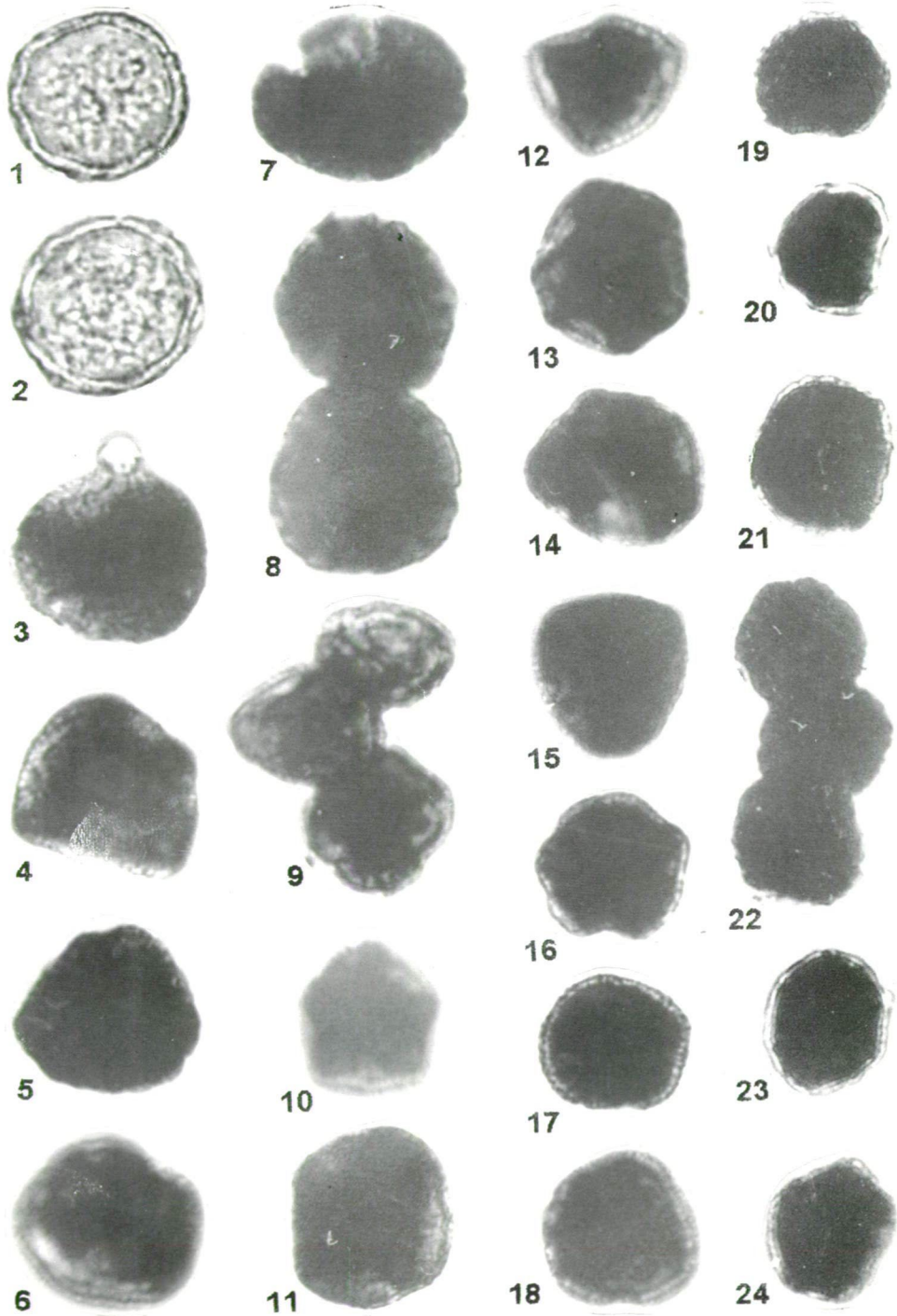

Plate 14.2.

Discussion and Conclusions

Based on our new results we can emphasize the following:

1. The spherical, polyaperturate pollen grains of *Buxus sempervirens* are resistant against high temperature effect, similar to other pollen grains of the same morphological type independently from taxonomical relationships. To this we cite M. VAN CAMPO (1967), p. 65: "Les ensembles polliniques successiformes peuvent se rencontrer dans des familles parfois éloignées les unes des autres, .." But the alteration of the ambitus is different in contrast to the *Juglans* pollen grains. There are some secondary forms similar to the triaperturate pollen grains (Plate 14.2., figs. 5,12,15).

2. WODEHOUSE (1935) pointed out that rounded apertures, for example *Chenopodiaceae* are in really shortened furrows. Our qualitative results support this establishment. Moreover it seems that the earlier forms of the succesiformity appeared polyforate forms - pericolpate, see fig. 7, in Plate 14.2.

Heating, based on our up-to-date experiments resulted in opposite successiform model.

Acknowledgements

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Plate 14.1.

1-8. Buxus sempervirens L., fresh pollen grains, 2500x.

Plate 14.2.

1-24. Buxus sempervirens L. magnification of all photographs, 1000x.
1,2. Fresh pollen grains, Experiment No: T9-P-1; 3,4. Experiment No: T9-P-2; 5,6. Experiment No: T9-P-3; 7-9. Experiment No: T9-P-4; 10-12. Experiment No: T9-P-5; 13-15. Experiment No: T9-P-6; 16-18. Experiment No: T9-P-7; 19-21. Experiment No: T9-P-8; 22-24. Experiment No: T9-P-9.

15. THERMAL EFFECT ON SOME EXTANT PALM POLLEN

M. KEDVES[1], A. BORBOLA[1], S.K.M. TRIPATHI[2] and MADHAV KUMAR[2]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary, 2. Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow - 226007, India

Abstract

Pollen grains of twenty species belonging to the family *Arecaceae* were investigated to study the effect of high temperature. Fresh and heated pollen grains at 200 °C were the subject of our investigations with the LM method. The qualitative and quantitative analyses of thermally altered pollen grains with respect to the morphological changes are presented herein. Alterations in general characters of investigated pollen depend on the basic morphology of individual grain. Changes in the size, sculptural elements, thickness and structure of the exine were noticed.

Key words: Palynology, extant palm, high temperature effect.

Introduction

Spores and pollen are the most sensitive indicators to high energy. The colour of microfossil changes during post-burial time due to high temperature and radioactive minerals present in the sediments. The rise of temperature may be attributed to the overburden of sediments and proximity to the igneous sources or the shear zone. At high energy levels organic molecules are subjected to degradation and destruction resulting into change of colour. The original land plant material is often pale yellow to light brown in colour which progressively changes through dark brown to opaque black when it undergoes thermal alteration at increased temperature (GRAY, 1975). The colour of microfossils provides an index for the degree of decomposition and it indicates the level of energy that has affected the rock since its lithification (DORRING, 1986).

The colour of microfossils is of particular interest to the petroleum geologist as it enables to predict the environment conductive to hydrocarbon generation. These studies provide a clue for better understanding about the regional history and source rock evaluation.

The first study dealing with effect of high temperature on the *angiosperm* pollen grains was made by KEDVES and KINCSEK (1989). *Normapolles*-like forms, which are characteristic of the Upper Cretaceous sediments of Europe appeared from recent *Corylus* and *Betula* pollen grains. It was emphasized, that the qualitative alterations of the different taxa of the investigated *brevaxonate Amentiflorae* pollen grains are not the same. Three types can be distinguished: 1. *Corylus, Betula* - important qualitative changes and early morphological characteristic features appeared. 2. *Carpinus* - qualitative changes are not so characteristic. 3. *Juglans* - qualitative changes were not ob-

served after heating. Later, KEDVES, TÓTH and FARKAS (1991) emphasized the following: p. 25: "Detailed methological investigations were carried out on two kinds of recent inaperturate pollen grains (*Juniperus virginiana* L., *Taxus baccata* L.). In consequence of high temperature, secondary changes for *angiosperm* characteristic features appeared on these pollen grains." KEDVES et al. (1993) observed that after heating monocolpate pollen of *Magnolia* (*Magnoliaceae*) and *Chamaedorea elegans* (*Arecaceae*) the shape and P/E ratio changed. In another paper (KEDVES, 1994) pointed out the following: p. 68: "1. The high temperature effect to the recent spores and pollen grains in taxonomical and/or phylogenetical respect has heterogeneous character. Advanced and early characteristic features may appear or in several cases the qualitative effect is neutral. 2. The linear alterations in the temperature and length of time also result in different changes in the qualitative and quantitative characteristic features of the sporomorphs. 3. The high temperature effect change the biopolymer organization of the sporoderm."

The first publication of the LM morphology of the palm pollen grains was of FRITZSCHE (1832, in ERDTMAN, 1952). Later several monographical elaborations, and basic morphological publications were published: ERDTMAN (1944, 1952), THANIKAIMONI (1966, 1970), PUNT and WESSELS BOER (1966), MALLIK and CHAUDHURI (1966-67), SOWUNMI (1968, 1972), KEDVES (1980), FERGUSON (1981, 1986), FERGUSON, DRANSFIELD, PAGE and THANIKAIMONI (1983), FERGUSON, HARVARD and DRANSFIELD (1987), DRANSFIELD, FERGUSON and UBAL (1990), HARLEY (1990), HARLEY and HALL (1991), FERGUSON and HARLEY (1993), and AMBWANI and KUMAR (1993), etc.

The aim of this paper is to investigate the alterations in morphological characteristics in arecaceous pollen after being subjected to high temperature for varying durations. The secondary altered forms are significant for comparative study of fossil palm pollen isolated from pre-Quaternary sediments.

Materials and Methods

The polliniferous material for investigations were collected by S.K.M. TRIPATHI and M. KUMAR from various localities, herbaria, botanical gardens and palynological laboratories. Pollen grains were kept at 200 °C for 1 hour, 25 hours and 100 hours. Slides of these pollen were mounted in glycerin-jelly hydrated at 39.6% and studied under light microscope. In most of the cases morphological alterations in 200 specimens of each species were observed to record changes in dimension, symmetry, exine sculpture and colour. Duration of heating for different species was as under:

1 hour: *Chrysalidocarpus lutescens, Kentia* sp., *Pseudophoenix ekmanii, Hyphaene indica, Nypa fruticans.*

25 hours, and 100 hours: *Chrysalidocarpus lutescens, Cocos nucifera, Roystonea regia, Livistona chinensis, Phoenix sylvestris, P. paludosa, Areca catechu, Elaeis guineensis, Caryota urens, Iriartea ventricosa, Borassus flabellifer, Dictyosperma album, Arenga pinnata, Mauritia flexuosa, Licuala spinosa, Pinanga javanica.*

Results

Chrysalidocarpus lutescens WENDL.
(Plate 15.1., figs. 1-6)

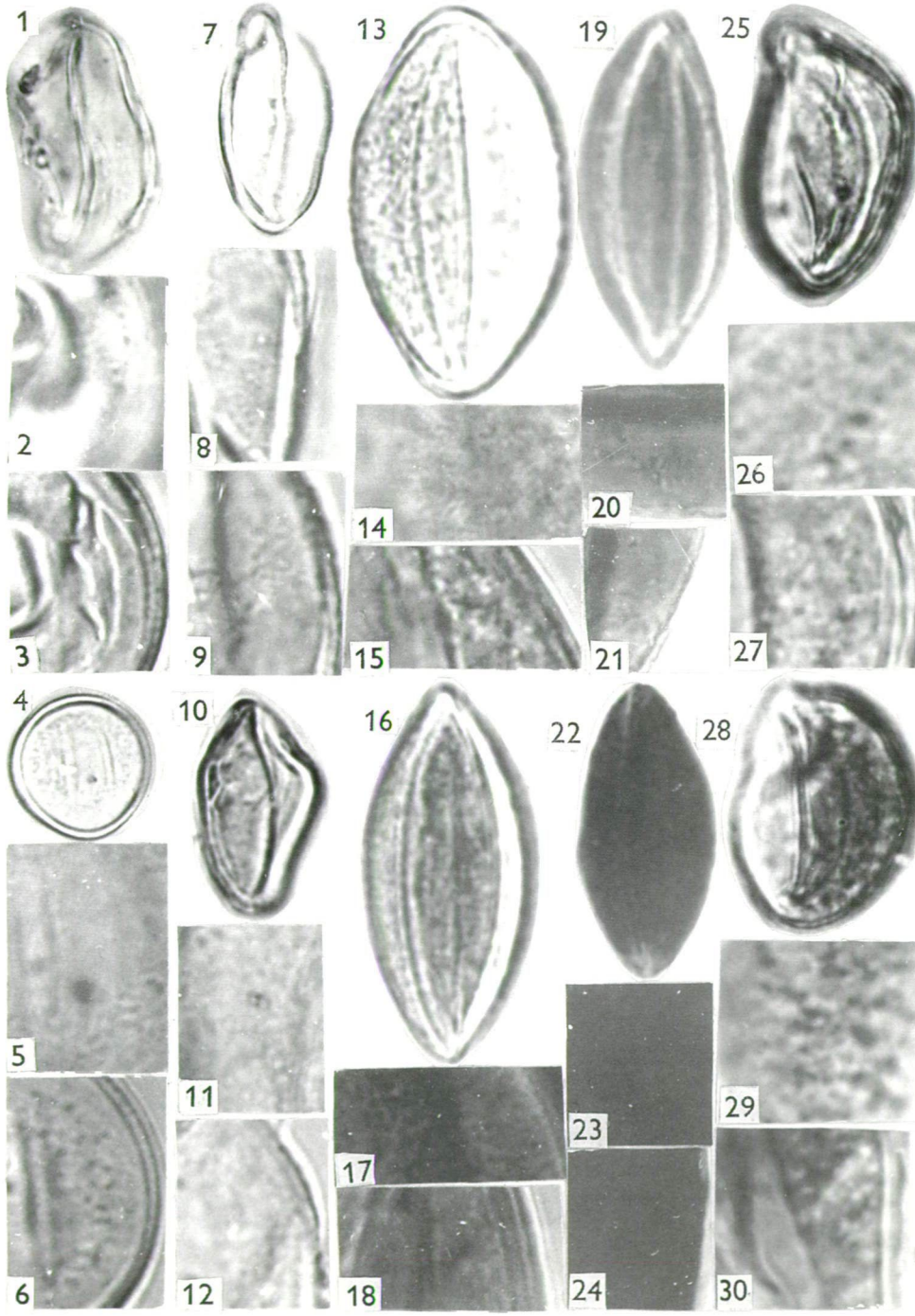
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Plate 15.1.

Pollen grains elliptical in shape. Monosulcate, sulcus extending from end to end. Exine 1.5-2 μm thick, scabrate. After 1 hour of heating marked reduction in size leading to a spheroidal shape was noticed.

Kentia sp.
(Plate 15.1., figs. 7-12)

Pollen grains elliptical in shape. Monosulcate, sulcus extending from end to end. Exine 1-2 μm thick, scabrate. After 1 hour heating size of pollen slightly reduced, exine moderately thickened.

Cocos nucifera LINN.
(Plate 15.1., figs. 13-24, Table 15.1.)

Pollen grains oval to elliptical in shape, lateral ends rounded, rarely pointed. Monosulcate, sulcus long, extending up to lateral ends. Exine 1.5-2.0 μm thick psilate to scabrate. Morphological alterations due to high temperature are clearly discernible. After 1 hour of heating the colour changes to light brown and equatorial diameter starts decreasing with thinning of exine at poles. After 25 hours colour of the pollen changed to light brown. The reduction in polar diameter from 70 x 52 to 51 x 45 μm and in equatorial diameter from 30 to 20 μm was noticed. At 100 hours remarkable reduction in size and exinal sculptures were observed. At this stage the lateral ends became more pointed.

Roystonea regia (H.B.K.) COOK
(Plate 15.1., figs. 25-30, Plate 15.2., figs. 1-6, Table 15.1.)

Pollen grains elliptical to oval in shape. Monosulcate, sulcus extending up to lateral ends. Exine tectate, fossulate. After 1 hour of heating no markable effect on exine sculpture was seen but reduction in size of pollen was noticed. Appearance of thickening of exine around sulcus is characteristic feature at 25 hours whereas, reduction in polar diameter and widening of sulcus was observed after 100 hours. In some pollen a concavity at the apertural side was observed.

Livistona chinensis (JACQ.) R. BR. ex MART.
(Plate 15.2., figs. 7-18, Table 15.2.)

Pollen grains oval to elliptical in shape. Monosulcate, sulcus extending up to lateral ends. Exine microreticulate, reticulations formed by fusion of pilae heads.

Plate 15.1.

1-3. *Chrysalidocarpus lutescens* WENDL., 0 hour, 1. 1000x, 2,3. 2500x.
4-6. *C. lutescens* WENDL., 1 hour, 4. 1000x, 5,6. 2500x.
7-9. *Kentia* sp., 0 hour, 7. 1000x, 8,9. 2500x.
10-12. *K.* sp., 1 hour, 10. 1000x, 11,12. 2500x.
13-15. *Cocos nucifera* LINN., 0 hour, 13. 1000x, 14,15. 2500x.
16-18. *C. nucifera* LINN., 1 hour. 16. 1000x, 17,18. 2500x.
19-21. *C. nucifera* LINN., 25 hours, 19. 1000x, 20,21. 2500x.
22-24. *C. nucifera* LINN., 100 hours, 22. 1000x, 23,24. 2500x.
25-27. *Roystonea regia* (H.B.K.) COOK., 0 hour, 25. 1000x, 26,27. 2500x.
28-30. *R. regia* (H.B.K.) COOK., 1 hour, 28. 1000x, 29,30. 2500x.

Table 15.1.

Species	Length of time	POLAR AXIS				L/S RATIO				
		Smallest (S) size (μm)	Dominant size (μm)	Largest (L) size (μm)	Δ=L-S (μm)	Smallest size (s)	Dominant size	Largest size (l)	Δ= l-s	X
Cocos nucifera	0	52.5	65	72.5	20	1.4	1.8	2.5	1.1	200
	1 hr	52.5	63.79	70	17.5	1.7	2.32	2.8	1.1	200
	25 hrs	47.5	56.94	62.5	15	1.8	2.35	2.8	1	200
	100 hrs	45	51.11	57.5	12.5	1.9	2.37	3.2	1.3	200
Iriartea ventricosa	0	22.5	28.21	32.5	10	1	1.24	1.7	0.7	200
	1 hr	25	28.86	32.5	7.5	1.4	1.60	1.9	0.5	200
	25 hrs	20	24.04	27.5	7.5	1.1	1.41	2	0.9	200
	100 hrs	17.5	21.57	25	7.5	1.1	1.29	1.5	0.4	200
Licuala spinosa	0	32.5	37.85	42.5	10	1	1.09	1.2	0.2	200
	1 hr	30	34.02	40	10	1	1.10	1.3	0.3	200
	25 hrs	25	29.42	32.5	7.5	1	1.09	1.3	0.3	200
	100 hrs	22.5	26.97	32.5	10	1	1.11	1.4	0.4	200
Phoenix sylvestris	0	12.5	17.20	22.5	10	1	1.21	1.6	0.6	200
	1 hr	12.5	16.29	25	12.5	1	1.20	1.7	0.7	200
	25 hrs	12.5	14.52	20	7.5	1	1.18	1.6	0.6	200
	100 hrs	10	12.91	15	5	1	1.16	1.5	0.5	200
Pinanga javanica	0	30	37.50	45	15	1	1.19	1.7	0.7	200
	1 hr	27.5	34.89	40	12.5	1	1.28	1.9	0.9	200
	25 hrs	27.5	31.52	37.5	10	1	1.23	1.6	0.6	200
	100 hrs	25	29.44	35	10	1	1.13	1.3	0.3	200
Roystonea regia	0	37.5	41.36	47.5	10	1	1.24	1.7	0.7	200
	1 hr	32.5	39.71	47.5	15	1	1.25	1.9	0.9	200
	25 hrs	27.5	35.04	40	12.5	1	1.29	1.6	0.6	200
	100 hrs	25	30.66	37.5	12.5	1	1.29	1.7	0.7	200

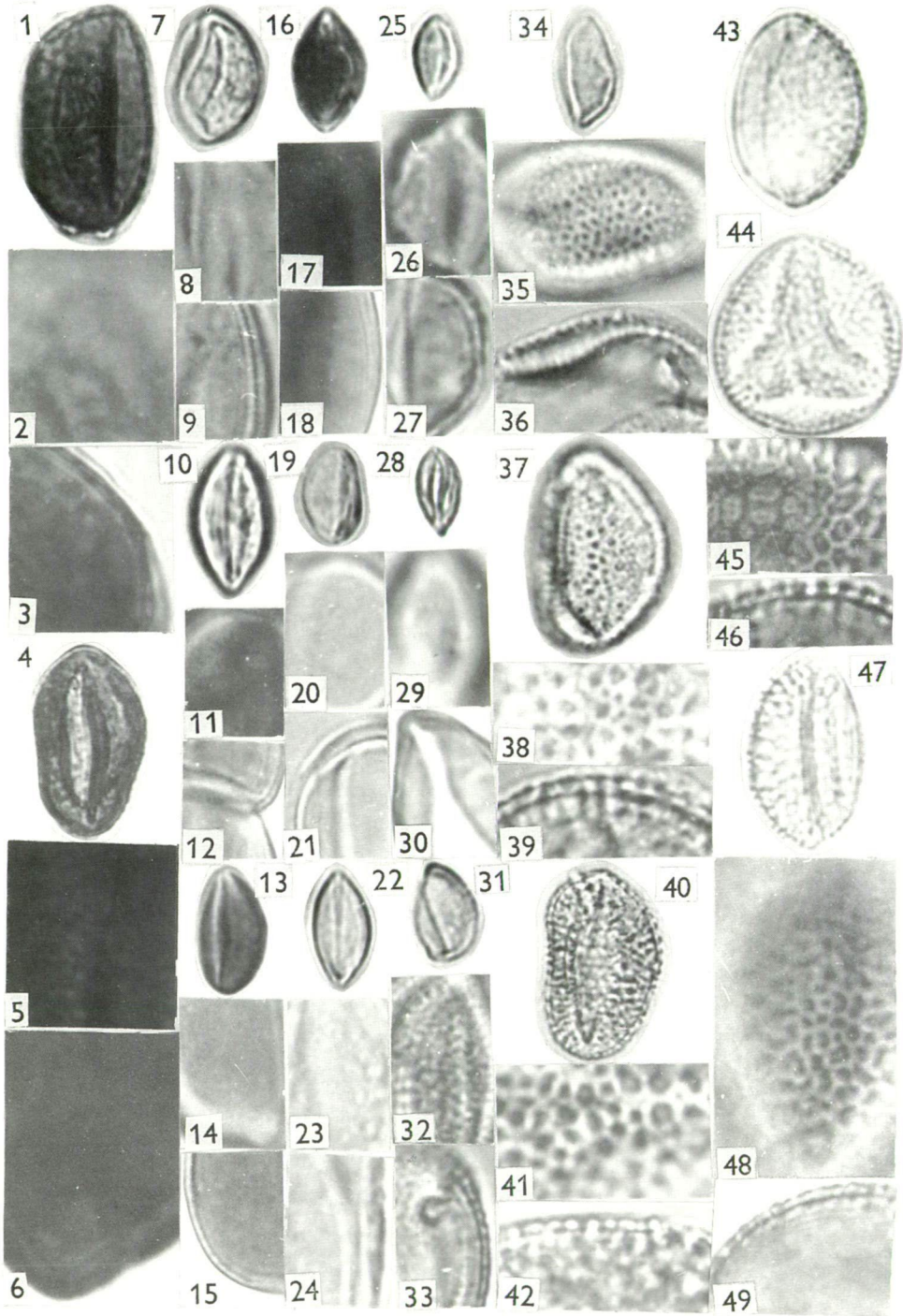
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Plate 15.2.

Pollen grains after 1 hour heating show reduction in P/E diameter. After 25 hours heating reduction in equatorial diameter and thickening of exine around sulcus was observed, reticulations became more clear and pilae heads increased in size. After 100 hours smoothness in sculpture and reduction in size was noticed.

Phoenix sylvestris (LINN.) ROXB.
(Plate 15.2., figs. 19-30, Table 15.1.)

Pollen grains oval-elliptical in shape. Monosulcate, sulcus long, extending up to lateral ends. Exine scabrate to finely reticulate. No appreciable change in morphology after 1 hour and 25 hours was seen. After 100 hours pollen became light brown in colour and reduction in size was noticed.

Phoenix paludosa ROXB.
(Plate 15.2., figs. 31-36)

Pollen elliptical to oval-elliptical in shape. Monosulcate, sulcus long. Exine 1.5-2.0 μm thick, microreticulate, retipilate. No appreciable change was noticed after 1 hour heating.

Pseudophoenix ekmanii BURRET
(Plate 15.2., figs. 37-42)

Pollen grains oval-elliptical in shape. Monosulcate, longisulcate. Exine 1.5-2.0 μm thick, semitectate, microreticulate, retipilate. After 1 hour of heating pollen turned golden in colour. Exine slightly thickens around aperture.

Areca catechu LINN.
(Plate 15.2., figs. 43-49)

Pollen grains oval in shape, showing variation of aperture, viz., monosulcate and trichotomosulcate. Exine 2.0-2.5 μm thick, microreticulate, retipilate. After 1 hour heating reduction in P/E diameter was observed. Thickening of exine around sulcus was noticed. Some pollen exhibit curving at the apertural face.

Plate 15.2.

1-3. *Roystonea regia* (H.B.K.) COOK., 25 hours, 1. 1000x, 2,3. 2500x.
4-6. *R. regia.* (H.B.K.) COOK., 100 hours, 4. 1000x, 5,6. 2500x.
7-9. *Livistona chinensis* (JACQ.) R. BR. ex MART., 0 hour, 7. 1000x, 8,9. 2500x.
10-12. *L. chinensis* (JACQ.) R. BR. ex MART., 1 hour, 10. 1000x, 11,12. 2500x.
13-15. *L. chinensis* (JACQ.) R. BR. ex MART., 25 hours, 13. 1000x, 14,15. 2500x.
16-18. *L. chinensis* (JACQ.) R. BR. ex MART., 100 hours , 16. 1000x, 17,18. 2500x.
19-21. *Phoenix sylvestris* (L.) ROXB., 0 hour, 19. 1000x, 20,21. 2500x.
22-24. *P. sylvestris* (L.) ROXB., 1 hour, 22. 1000x, 23,24. 2500x.
25-27. *P. sylvestris* (L.) ROXB., 25 hours, 25. 1000x, 26,27. 2500x.
28-30. *P. sylvestris* (L.) ROXB., 100 hours, 28. 1000x, 29,30. 2500x.
31-33. *Phoenix paludosa* ROXB., 0 hour, 31. 1000x, 32,33. 2500x.
34-36 *P. paludosa* ROXB., 1 hour, 34. 1000x, 35,36. 2500x.
37-39. *Pseudophoenix ekmanii* BURRET., 0 hour, 37. 1000x, 38,39. 2500x.
40-42. *P. ekmanii* BURRET., 1 hour, 40. 1000x, 41,42. 2500x.
43-46. *Areca catechu* LINN., 0 hour, 43-44. 1000x, 45,46. 2500x.
47-49. *A. catechu* LINN. 1 hour, 47. 1000x, 48,49. 2500x.

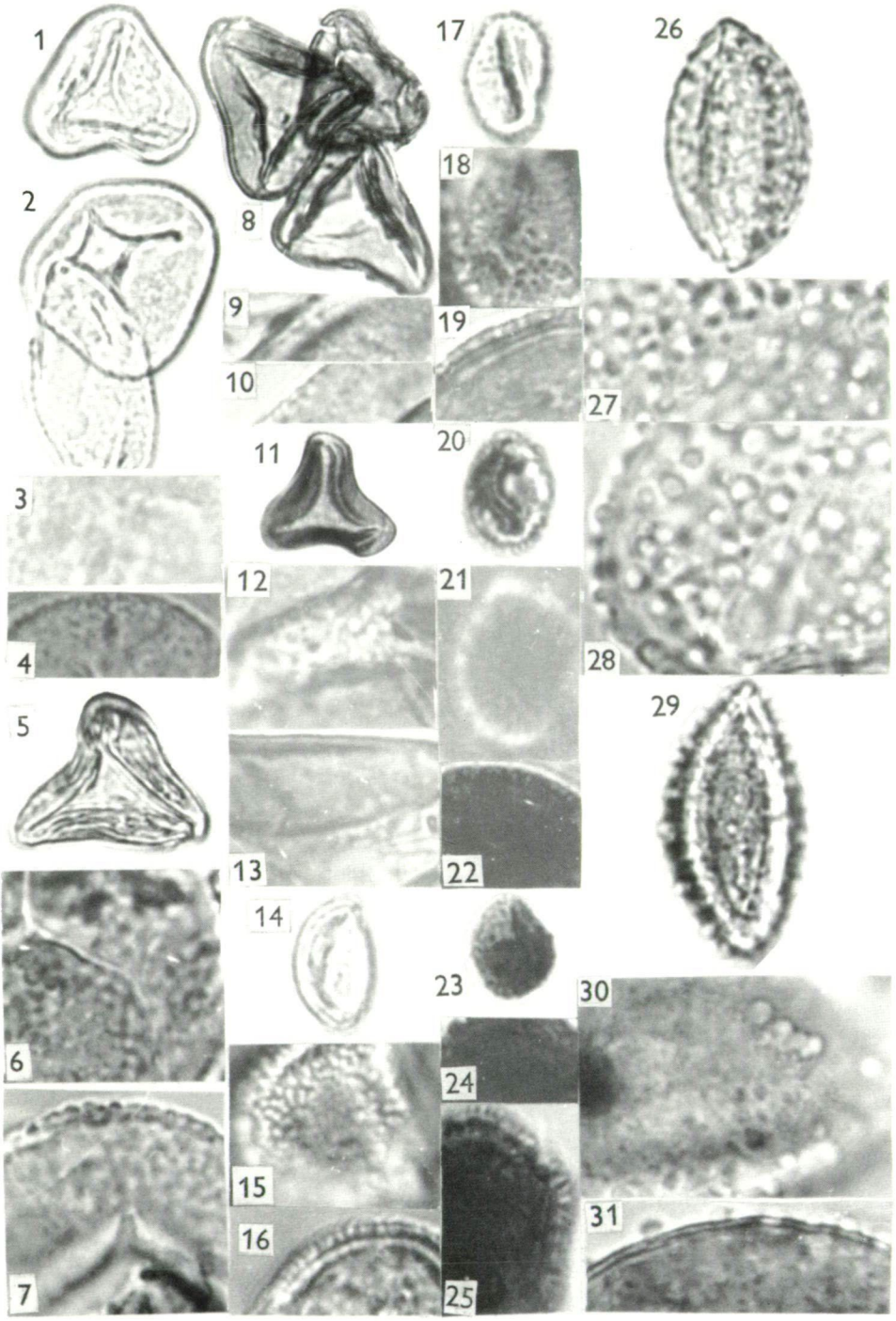
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Plate 15.3.

Elaeis guineensis JACQ.
(Plate 15.3., figs. 1-13)

Pollen grains elliptical or triangular to subcircular in shape, showing apertural variation such as monosulcate, trichotomosulcate and tetratomosulcate. Exine 1.5 µm thick semitectate, finely punctate. After 1 hour heating no considerable change was noticed except concavity in interradial region. After 25 and 100 hours the exine sculpture diminishes in size and concavity between inter-radials region increases.

Caryota urens LINN.
(Plate 15.3., figs. 14-25)

Pollen grains oval in shape. Monosulcate. Exine semitectate, clavate-reticulate, microreticulate. After 1 hour heating slight reduction in equatorial diameter of the grain was observed but after 25 hours decrease in P/E diameter was more pronounced. After 100 hours reduction in the diameter of pilae head, diminishing of reticulations and decrease in the size of the grain were noticed.

Hyphaene indica BECC.
(Plate 15.3., figs. 26-31)

Pollen grains elliptical in shape. Monosulcate, sulcus extending up to lateral ends. Exine semitectate, gemmate, gemmae supratectal, spaces between gemmae microreticulate to scabrate. After 1 hour heating pollen grains show remarkable decrease in equatorial diameter and thinning of exine. The reduction in height and diameter of gemmae and less in their quantity is a characteristic feature at this stage. The intergemmal spaces appear to be faintly reticulate.

Iriartea ventricosa MART.
(Plate 15.4., figs. 1-12, Table 15.1.)

Pollen grains oval in shape. Monosulcate, sulcus long, extending up to lateral ends. Exine 2-4 µm thick, pilate, pilae supratectal. Morphological alterations after 1 hour are clearly observed in this pollen. A gradual decrease in size at 1 h, 25 and 100 hour(s) is a characteristic phenomenon. At 1 hour reduction in diameter of pilae heads and thinning of exine was noticed which because more pronounced after 25 hours. The height of pilae are also reduced after 25 hours and these appears like warts after 100 hours.

Plate 15.3.

1-4. *Elaeis guineensis* JACQ., 0 hour, 1,2. 1000x, 3,4. 2500x.
5-7. *E. guineensis* JACQ., 1 hour, 5. 1000x, 6,7. 2500x.
8-10. *E. guineensis* JACQ., 25 hours, 8. 1000x, 9,10. 2500x.
11-13. *E. guineensis* JACQ., 100 hours, 11. 1000x, 12,13. 2500x.
14-16. *Caryota urens* LINN., 0 hour, 14. 1000x, 15,16. 2500x.
17-19. *C. urens* LINN., 1 hour, 17. 1000x, 18,19. 2500x.
20-22. *C. urens* LINN., 25 hours, 20. 1000x, 21,22. 2500x.
23-25. *C. urens* LINN., 100 hours, 23. 1000x, 24,25. 2500x.
26-28. *Hyphaene indica* BECC., 0 hour, 26. 1000x, 27,28. 2500x.
29-31. *Hyphaene indica* BECC., 1 hour, 29. 1000x, 30,31. 2500x.

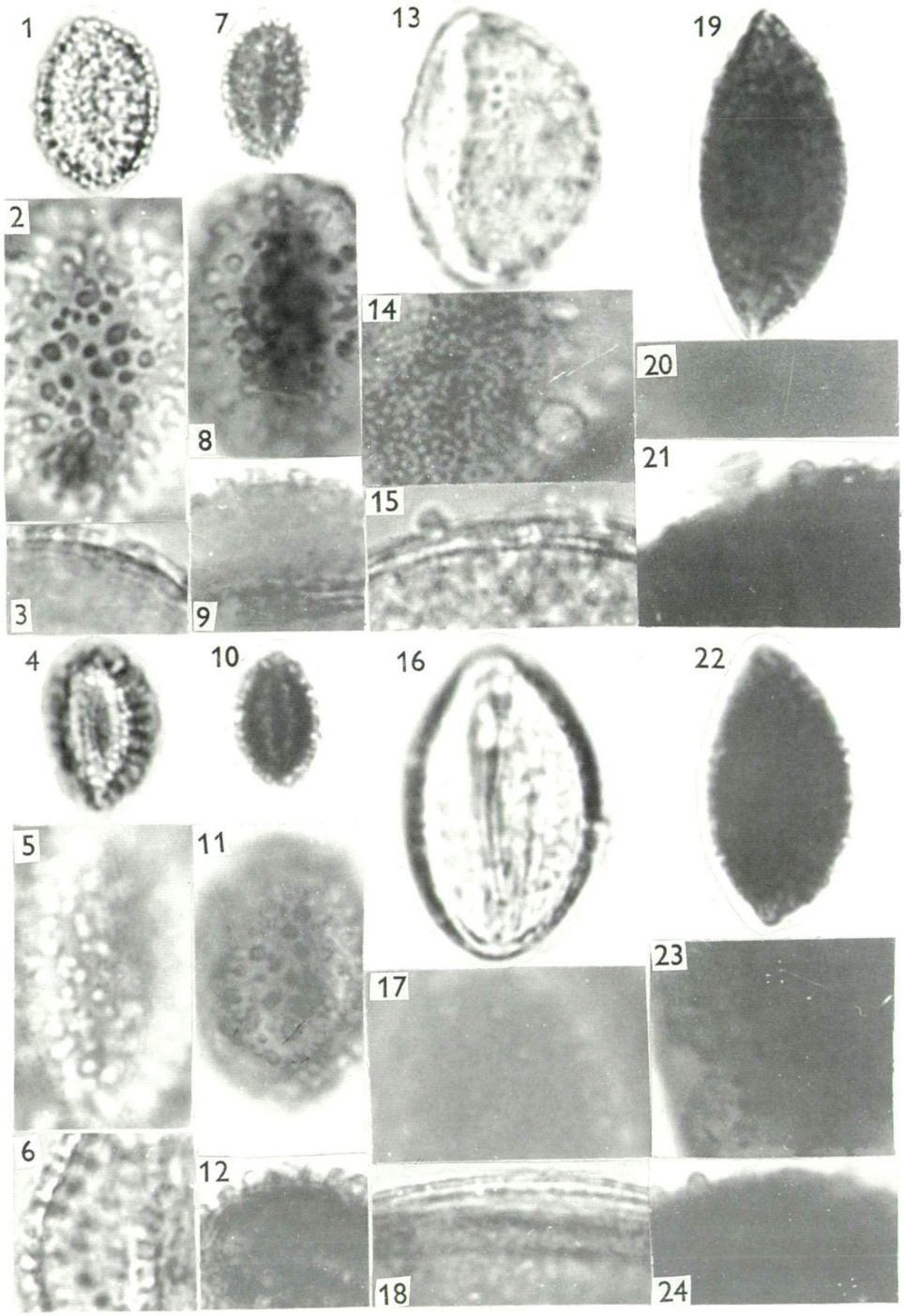

Plate 15.4.

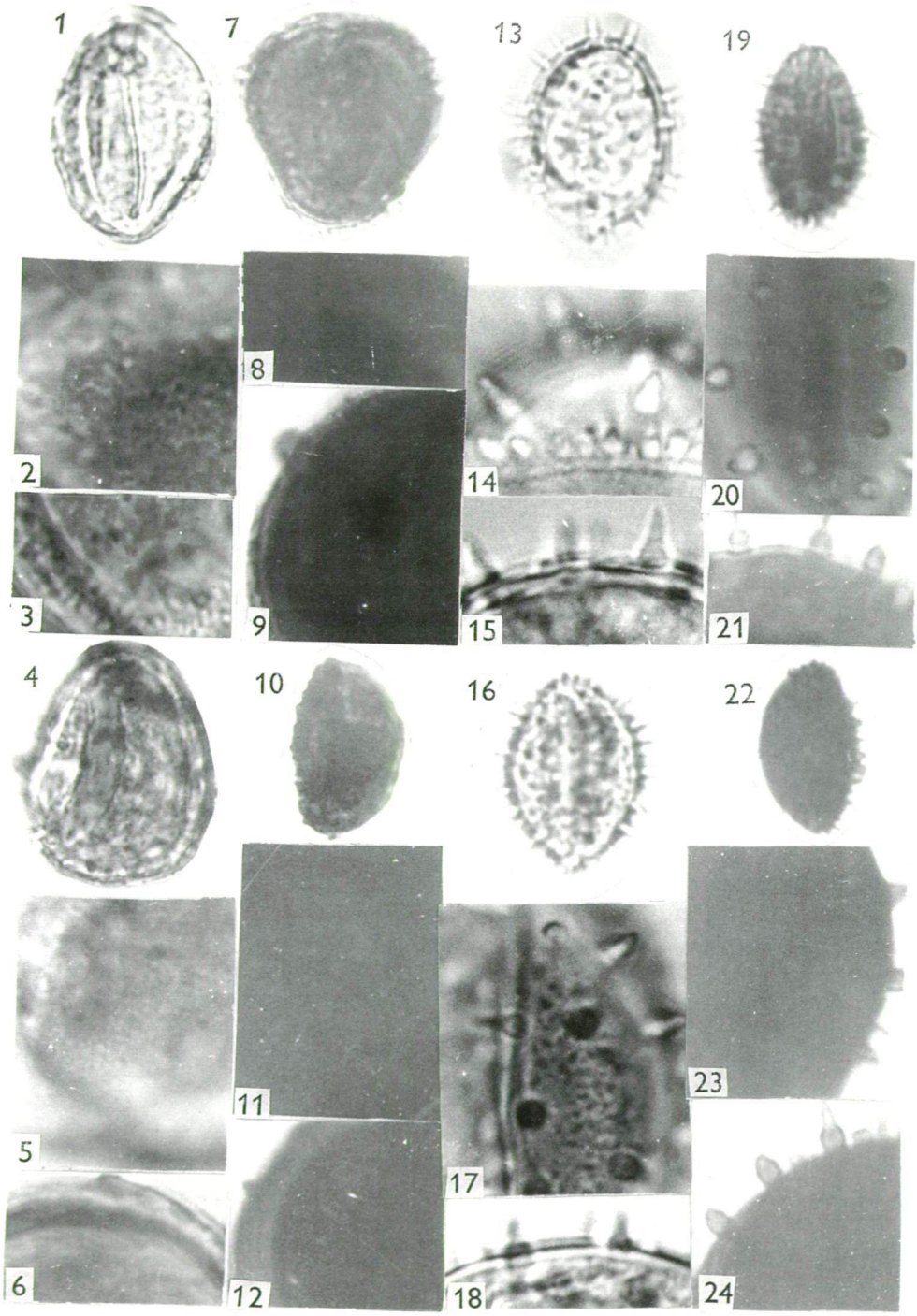

Plate 15.5.

Borassus flabellifer LINN.
(Plate 15.4., figs. 13-24, Table 15.2.)

Pollen grains oval in shape. Monosulcate, sulcus long widely open. Exine 1.5-2.0 μm thick, gemmate, baculate, granulate: exine ornamentation supratectal. Morphological alterations in consequence to the high temperature are clearly visible in this pollen. After 1 and 25 hour(s) a gradual increase in polar diameter and reduction in size and quantity of sculptural elements were observed. The thinning of exine is also observed during 1-100 hours. A remarkable decrease (5-7 μm) in polar diameter and reduction in size of sculptural elements are the result of 100 hours heating.

Dictyosperma album H. WENDL. et DRUDE ex SCHEFF.
(Plate 15.5., figs. 1-12, Table 15.2.)

Pollen grains oval to subcircular in shape. Monosulcate, sulcus long, extending up to lateral ends. Exine 1.5-2.5 μm thick. One hour heating increase in P/E diameter ratio but reduction in polar diameter was observed after 25-100 hours.

Arenga pinnata (WURMB.) MERR.
(Plate 15.5., figs. 13-24, Table 15.2.)

Pollen grain oval in shape. Monosulcate, sulcus medium to large. Sometimes extending up to lateral ends. Exine up to 1.5 μm thick spinose, spines with bulbous base and pointed tips, interspinal spaces laevigate. The important change in morphology after 1 hour is reduction in P/E diameter. After 25 hours further decrease in P/E diameter and thickness of exine were observed. Tips of spines became more slender. The morphological alterations after 100 hours are characteristically different. At this stage markable reduction in size, thinning of exine and disappearance of spine tips in large number of specimens were observed.

Plate 15.4.

1-3. *Iriartea ventricosa* MART., 0 hour, 1. 1000x, 2,3. 2500x.
4-6. *I. ventricosa* MART., 1 hour, 4. 1000x, 5,6. 2500x.
7-9. *I. ventricosa* MART., 25 hours, 7. 1000x, 8,9. 2500x.
10-12. *I. ventricosa* MART., 100 hours, 10. 1000x, 11,12. 2500x.
13-15. *Borassus flabellifer* LINN., 0 hour, 13. 1000x 14,15. 2500x.
16-18. *B. flabellifer* LINN., 1 hour, 16. 1000x, 17,18. 2500x.
19-21. *B. flabellifer* LINN., 25 hours, 19. 1000x, 20,21. 2500x.
22-24. *B. flabellifer* LINN., 100 hours, 22. 1000x, 23,24. 2500x.

Plate 15.5.

1-3. *Dictyosperma album* H. WENDEL. et DRUDE ex SCHEFF., 0 hour, 1. 1000x, 2,3. 2500x.
4-6. *D. album* H. WENDEL et DRUDE ex SCHEFF., 1 hour, 4. 1000x. 5,6. 2500x.
7-9. *D. album* H. WENDEL et DRUDE ex SCHEFF., 25 hours, 7. 1000x, 8,9. 2500x.
10-12. *D. album* H. WENDEL et DRUDE ex SCHEFF., 100 hours, 10. 1000x, 11,12. 2500x.
13-15. *Arenga pinnata* (WURMB.) MERR., 0 hour, 13. 1000x, 14,15. 2500x.
16-18. *A. pinnata* (WURMB.) MERR., 1 hour, 16. 1000x, 17,18. 2500x.
19-21. *A. pinnata* (WURMB.) MERR., 25 hours, 19. 1000x, 20,21. 2500x.
22-24. *A. pinnata* (WURMB.) MERR., 100 hours, 22. 1000x, 23,24. 2500x.

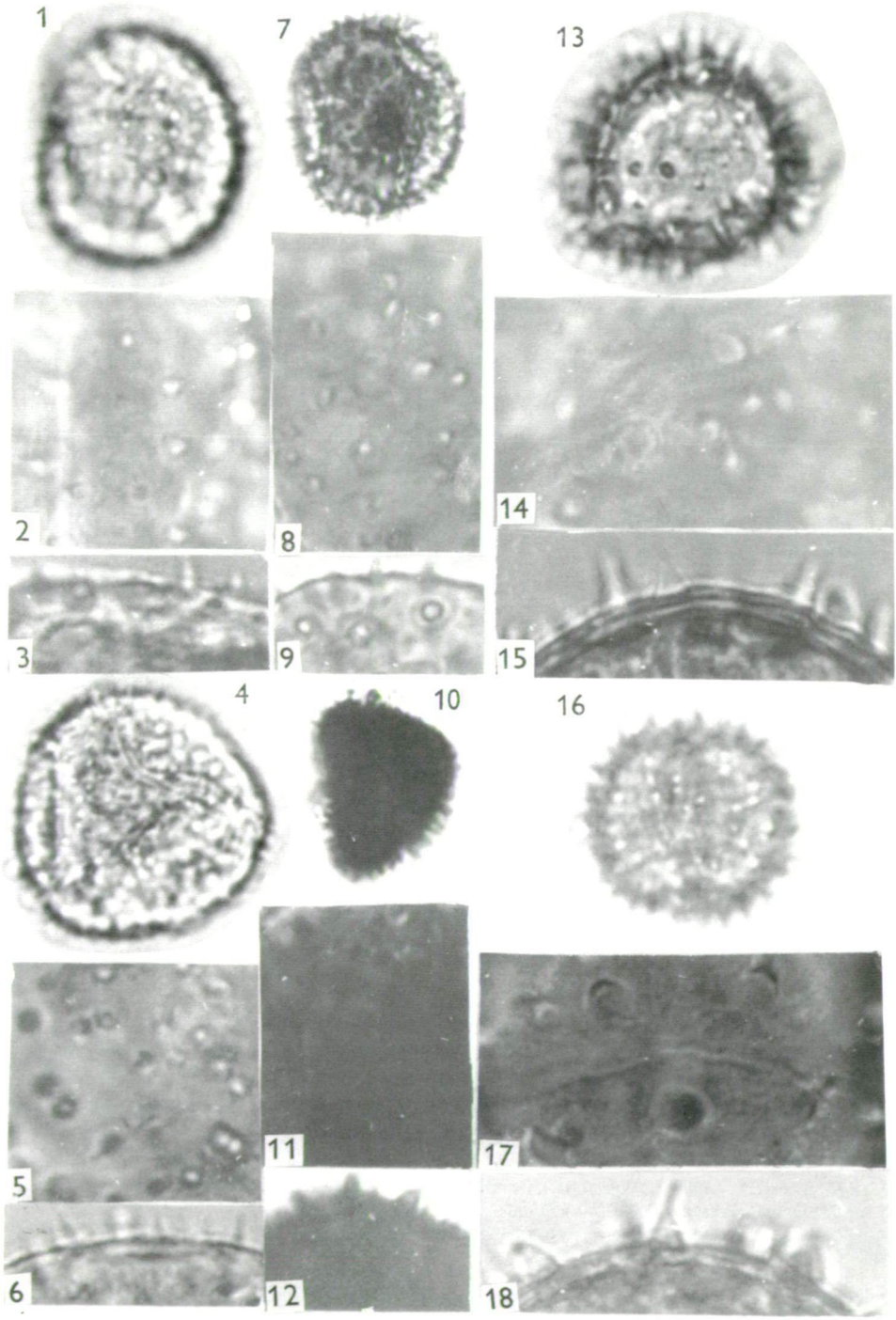

Plate 15.6.

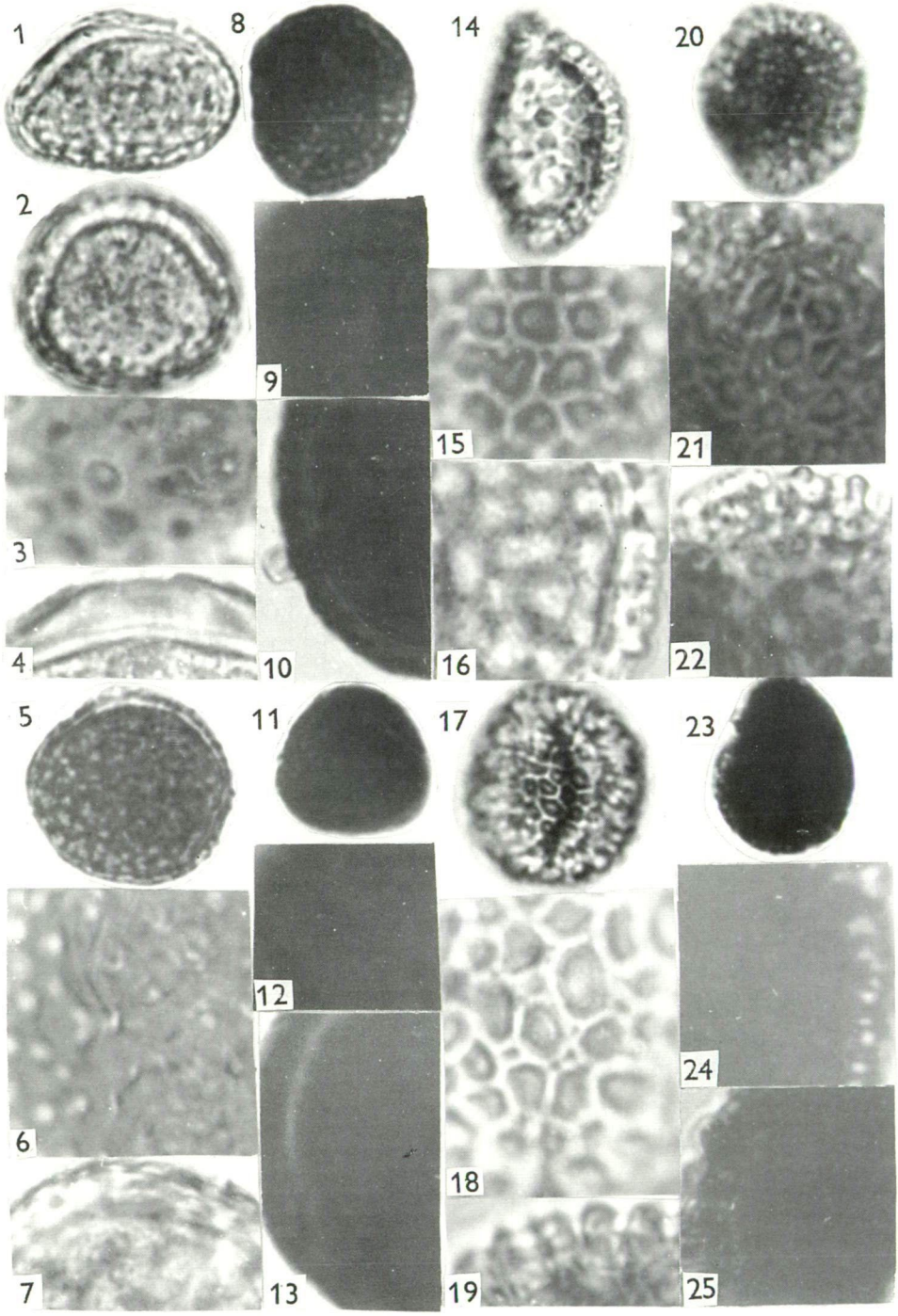

Plate 15.7.

Table 15.2.

Species	Length of time	Smallest (S) size (μm)	Dominant size (μm)	Largest (L) size (μm)	Δ=L-S (μm)	Smallest size (s)	Dominant size	Largest size (l)	Δ= l-s	X
Dictyosperma album	0	37.5	44.66	50	12.5	1	1.12	1.4	0.4	200
	1 hr	35	39.97	47.5	12.5	1	1.15	1.4	0.4	200
	25 hrs	20	26.25	42.5	22.5	1	1.31	2.5	1.5	52
	100 hrs	20	28.93	40	20	1	1.32	1.8	0.8	42
Livistona chinensis	0	20	23.19	27.5	7.5	1	1.32	1.7	0.7	200
	1 hr	20	22.56	27.5	7.5	1	1.35	1.7	0.7	200
	25 hrs	15	18.96	22.5	7.5	1	1.38	1.8	0.8	200
Mauritia flexuosa	0	37.5	46	57.5	20	1	1.15	1.7	0.7	200
	1 hr	37.5	43.87	55	17.5	1	1.13	1.4	0.4	200
	25 hrs	25	39.21	65	30	1	1.29	3.7	2.7	200
	100 hrs	20	35.76	75	55	1	1.31	3.6	2.5	161
Arenga pinnata	0 1/7-687	15	30.12	72.5	57.5	1	1.44	3.4	2.4	124
	0 -838	22.5	31.2	37.5	15	1	1.3	2.1	1.1	62
	1 hr -688	15	32.93	42.5	27.5	1	1.39	2	1	64
	1 hr -839	17.5	31.84	45	27.5	1	1.38	3	2	125
	25 hrs	20	31.28	50	30	1	1.44	2.3	1.3	84
	100 hrs	20	28.16	37.5	17.5	1	1.44	2	1	110
Borassus flabellifer	0 1/7-659	37.5	45.83	57.5	20	1	1.23	1.7	0.7	30
	0 -828	37.5	47.92	60	22.5	1	1.3	1.9	0.9	24
	1 hr -660	30	46.04	60	30	1.1	1.35	1.7	0.6	12
	25 hrs	27.5	47.43	75	47.5	1	1.67	3.4	2.4	71
	100 hrs	35	46.28	75	40	1.1	1.85	3.2	2.1	37

X means number of measured pollen grains.

Mauritia flexuosa LINN.
(Plate 15.6., figs. 1-12, Table 15.2.)

Pollen grains monosulcate, trichotomosulcate or ulcerate, sometimes aperture not clearly discernible. Exine 2-3 μm thick, spinose. Spines 2-3 μm long, slender, 5-6 μm apart. After 1 hour heating slight decrease in length of spines was noticed. After 25 hours pollen changed to brown in colour. Reduction in P/E diameter and slight thickening of exine around the sulcus were observed. After 100 hours colour changed to dark brown, spines reduced by 1.5 μm and decrease in size of pollen was noticed.

Nypa fruticans WURMB.
(Plate 15.6., figs. 13-18)

Pollen grains monosulcate, meridionosulcate. Exine tectate, perforate with supratectal spines. Spine bases broad and tips pointed. After 1 hour pollen became golden yellow in colour and slight reduction in size was noticed.

Licuala spinosa WURMB.
(Plate 15.7., figs. 1-13, Table 15.1.)

Pollen grains monosulcate, oval to elliptical in shape. Sulcus extending up to lateral ends. Exine distinctly reticulate. After 1 hour colour of pollen changed to golden brown, size of pollen got slightly reduced and shape of pollen changed to subtriangular to subcircular. After 25 hours further reduction in size, fainting of reticulation and change of pollen colour to dark brown were noticed. After 100 hours size of pollen reduced remarkably and shape changed to subtriangular. The reticulations disappeared and colour turned dark brown.

Pinanga javanica BLATER
(Plate 15.7., figs. 14-25, Table 15.1.)

Plate 15.6.

1-3. *Mauritia flexuosa* LINN., 0 hour, 1. 1000x, 2,3. 2500x.
4-6. *M. flexuosa* LINN., 1 hour, 4. 1000x, 5,6. 2500x.
7-9. *M. flexuosa* LINN., 25 hours, 7. 1000x, 8,9. 2500x.
10-12. *M. flexuosa* LINN., 100 hours, 10. 1000x, 11,12. 2500x.
13-15. *Nypa fruticans* WURMB., 0 hour, 13. 1000x, 14,15. 2500x.
16-18. *N. fruticans* WURMB., 1 hour, 16. 1000x, 17,18. 2500x.

Plate 15.7.

1-4. *Licuala spinosa* WURMB. 0 hour, 1,2. 1000x, 3,4. 2500x.
5-7. *L. spinosa* WURMB., 1 hour, 5. 1000x, 6,7. 2500x.
8-10. *L. spinosa* WURMB., 25 hours, 8. 1000x, 9,10. 2500x.
11-13. *L. spinosa* WURMB., 100 hours, 11. 1000x, 12,13. 2500x.
14-16. *Pinanga javanica* BLAT., 0 hour, 14. 1000x, 15,16. 2500x.
17-19. *P. javanica* BLAT., 1 hour, 17. 1000x, 18,19. 2500x.
20-22. *P. javanica* BLAT., 25 hours, 20. 1000x, 21,22. 2500x.
23-25. *P. javanica* BLAT., 100 hours, 23. 1000x 24,25. 2500x.

Pollen grains oval to elliptical in shape. Monosulcate, sulcus long, meridionosulcate. Exine 2.5-3.0 μm thick, semitectate, reticulate. After 1 hour heating increase in equatorial diameter and thickness of exine were noticed. Increase in diameter of baculae is also distinctly visible. At 25 hours a distinct reduction in P/E diameter and decrease in length of baculae as well as lumina were observed. After 100 hours the pollen further reduced in size and exine sculpture diminished.

Discussion and Conclusions

Present experiments suggest that most of the alterations appear after 1 hour heating at 200 °C and the modified features get more intensified after 25 and 100 hours. The changes include the qualitative (colour and shape) and quantitative characters. Important changes observed in heated pollen are as follows:

In *Elaeis guineensis* after 25 and 100 hours heating concavity in interradial region appeared (Plate 15.3., figs. 5,11) which results into narrowing of sulcus appearing more or less like a trilete mark.

Most of the investigated pollen exhibit reduction in size after heating for 25 and 100 hours. Reduction in size is pronounceably observed in pollen of *Mauritia flexuosa* (Plate 15.6., figs. 7,10), *Pinanga javanica* (Plate 15.7., figs. 20,23), *Iriartea ventricosa* (Plate 15.4., figs. 7,10) and *Arenga pinnata* (Plate 15.5., figs. 19,22).

The reticulate ornamentation in studied pollen remained unchangent after heating except in *Pinanga javanica* (Plate 15.7., figs. 20,25), *Caryota urens* (Plate 15.3., figs. 20-25) and *Iriartea ventricosa* (Plate 15.4., figs. 7-12) where the meshes diminished in size.

After heating the pollen of *Arenga pinnata* (Plate 15.5., figs. 16-24) and *Mauritia flexuosa* (Plate 15.6., figs. 7-12) for 25 and 100 hours the spines got reduced in size and the bases become more bulbosous. In *Hyphaene indica* (Plate 15.3., figs. 29-31) and *Borassus flabellifer* (Plate 15.4., figs. 16-24) number and size of gemmae got reduced as a response to heating.

In some pollen e.g. *Roystonea regia* (Plate 15.2., figs. 1,4), *Elaeis guineensis* (Plate 15.3., figs. 5,8,11), *Licuala spinosa* (Plate 15.7., figs. 5-8) and *Pinanga javanica* (Plate 15.7., figs. 17, 20) after heating the exine around sulcus thickened.

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16. NEW DATA ON THE MOLECULAR SYMMETRY AND ORGANIZATION OF THE QUASI-CRYSTALLOID SKELETON OF THE SPORODERM

M. KEDVES[1], Á. PÁRDUTZ[2] and M. MADARÁSZ[1]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, 2. Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, H-6701, P.O. Box 521, Szeged, Hungary

Abstract

During our experimental investigations on the partially dissolved and degraded pollen grains of *Ambrosia artemisiifolia* L. a degraded regular pentagon biopolymer unit was investigated with two dimensional symmetry operations. The tenfold primary rotation method resulted cyclic molecular clusters on the places of the globular units of the quasi-crystalloid skeleton in Angstrom dimension. This is the first molecular data about the globular units forming the regular pentagon which are the building elements of the metastable quasi-crystalloid skeleton. In this contribution we present a short and selected review on the results of the biopolymer organization and symmetry of the sporopollenin.

Key words: Palynology, *Ambrosia*, recent, molecular structure.

Introduction

The publications of ROWLEY (1978), ROWLEY, J.R., DAHL, and ROWLEY, J.S. (1980), ROWLEY, J.R., DAHL, SENGUPTA and ROWLEY, J.S. (1981), ROWLEY, J.R., EL-GHAZALY and ROWLEY, J.S. (1987) and SOUTHWORTH (1985a,b, 1986a,b) started investigations with the TEM method the sub-units of the partially degraded exines of the pollen grains. Following the discovery of the quasi-crystals on rapidly cooled AlMn alloy by SHECHTMAN, BLECH, GRACIAS and CAHN (1984) intensive researches started in the crystallography and the symmetry of inorganic and organic structures.

In 1988 the quasi-crystalloid biopolymer structure was discovered from living systems, first from the exine of *Pinus griffithii* MCCLELL (KEDVES, 1988). Later this metastable biopolymer skeleton was investigated by several, different methods on several biological objects. These may be summarized as follows:

1. Two dimensional symmetry operations with the modified Markham rotation method (KEDVES, 1989a, 1990, 1991b, KEDVES and FARKAS, 1991, KEDVES, FARKAS, MÉSZÁROS, TÓTH and VÉR, 1991, etc.)

2. Three dimensional modelling for the metastable quasi-crystalloid skeleton (KEDVES, 1991a, 1992).

3. Two dimensional modelling for the stabilizing biopolymer system of the metastable skeletal elements (KEDVES and TÓTH, 1994).

4. Computer modelling for the skeletal and the stabilizing biopolymer systems (KEDVES, M. and KEDVES, L., 1995, 1996, 1997, 1999).

5. After the discovery of the peculiar biopolymer organization of the wall of *Botryococcus braunii* KÜTZ. isolated from Hungarian oil shale, namely there are quasi-crystalloid network and larger units which may be modelled with fullerenes (KEDVES, ROJIK and VÉR, 1991) a peculiar attempt was made to the relationships and connections of these two completely contradictory organization. Till this time the relationships of the quasi-periodic and quasi-equivalent systems in biological material is not yet resolved but the first partial results were published by KEDVES, TRIPATHI, VÉR, PÁRDUTZ and ROJIK (1998).

The metastable biopolymer skeleton and one kind of the hypothetical stabilizing units was compiled on the basis of the results of transmission electronmicroscopical data (KEDVES, 1989b). As it was emphasized in the above mentioned paper the Penrose tiling was re-discovered exclusively based on the TEM results of the partially degraded exines, because first the author has not read the literature of the Mathematics. The most important publications of PENROSE (1979), MACKAY (1976, 1981, 1990), BURSILL and PENG JU LIN (1985), SACHDEV and NELSON (1985), AUDIER and DUYOT (1986), NELSON (1986), O'HANDLEY (1987), SCHNEER (1988) and the book of HARGITTAI (1990) were studied later.

General problems

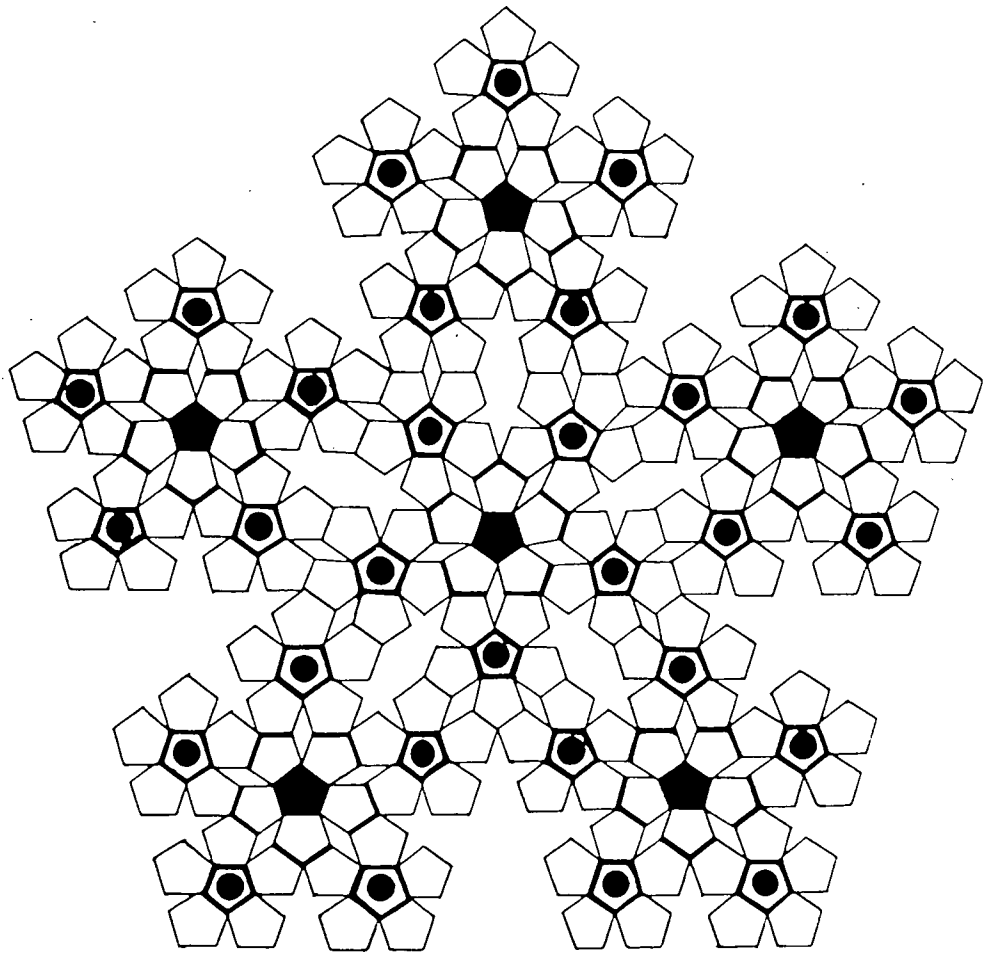
In the first place we re-publish the schema of KEDVES (1989b) concerning the metastable Penrose tiling (Text-fig. 16.1.). The most important characteristic is the presence of the frustrations sensu NELSON (1986). The quasiperiodic network does not fill the space, another so-called stabilizing system assure the equilibrum. On this schema one central stabilizing unit was illustrated. But without doubt there are several different kinds of molecular structures, which are filling the holes of the quasi-periodic network.

Text-fig. 16.2. is the reproduction of the fig. 1, p. 63 from the paper of KEDVES (1989b) illustrating the organization levels of the sporopollenin. The lower part is the molecular one sensu strictu. The molecular composition of the sporopollenin is also another very complicated problem, to this we cite without completeness some publications: BROOKS and SHAW (1973), MANSKAYA, KODINA and GENERALOVA (1973), RITTSCHER, GUBATZ and WIERMANN (1987), SCHULZE, OSTHOFF and WIERMANN (1987), KEDVES (1991b).

After the molecular system the units in Angstrom dimension are important. Two components are illustrated: 1. The metastable quasi-crystalloid skeleton. 2. The central stabilizing molecular system of the metastable skeleton. The most important characteristic feature of the units of this level of organization (diameter of the regular pentagon 14-28 Å about) is that after the Markham rotation of the regular pentagonal biopolymer units further points of symmetry appear, which are suitable for further symmetry operations, and among these the Penrose unit was also demonstrated. The quasi-crystalloid basic skeletal units may be building elements for further highly organized systems such as the helical, lamellar, globular structures in nanometer dimension.

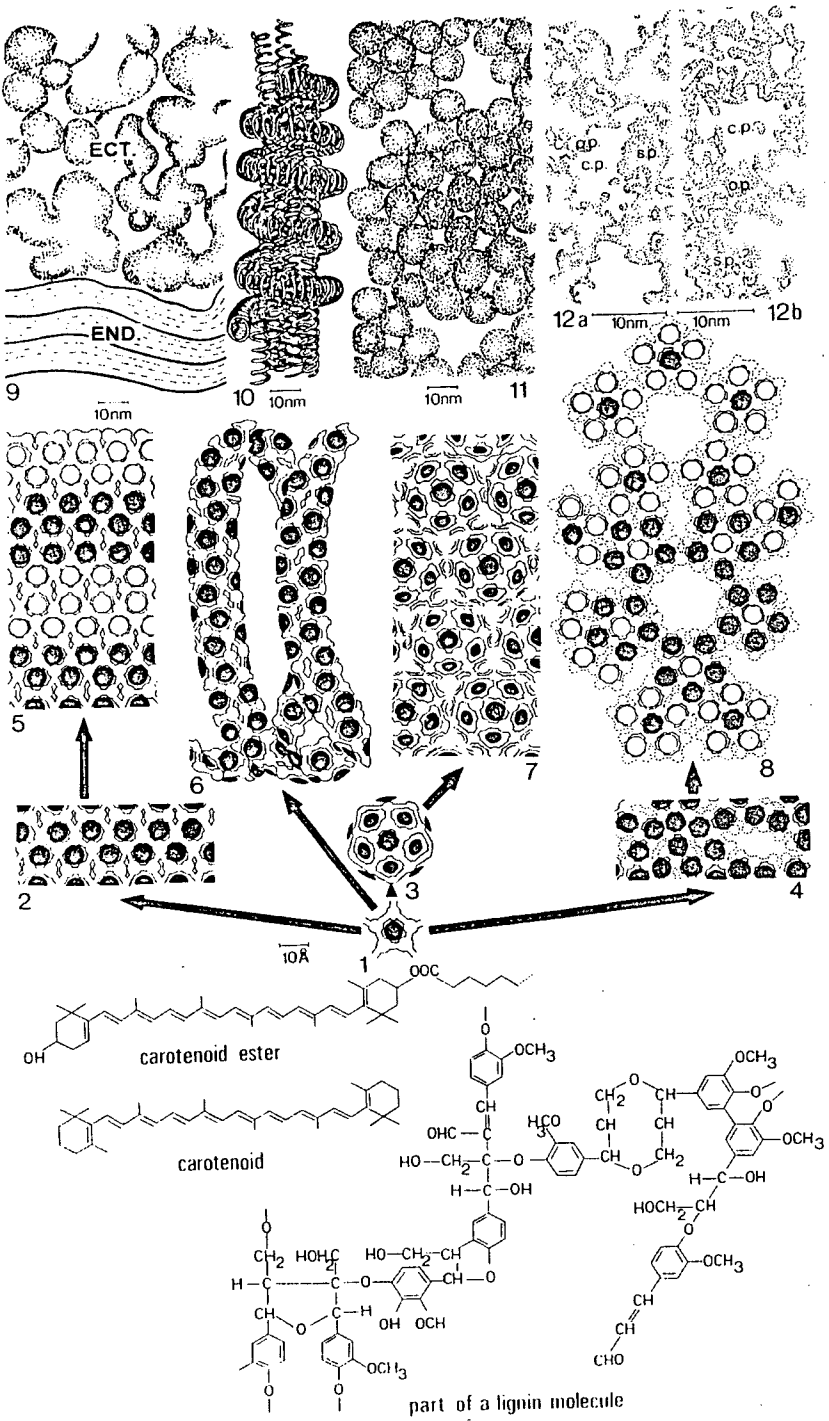
Regular pentagons may occur in nanometer dimension also (ROWLEY, 1967) but the Markham rotation never results in secondary points of symmetry.

Resuming the dimension is very important in the basic characteristic features of the regular pentagonal biopolymer structures, similarly to the colloids of the inorganic or organic materials.



Text-fig. 16.1.

Schema for the quasi-crystalloid biopolymer structure of the sporoderm, following KEDVES (1989b), p. 65.



Text-fig. 16.2.

The organization levels of the sporopollenin following KEDVES (1989b), Fig. 1, p. 63.

Materials and Methods

The investigation material was collected by Dr. M. KEDVES on the 08.09.1998. in Szeged on a weedy piece of ground. Several partial dissolution and degradation experiments were carried out on these pollen grains. One of them, No: 1/7-1394 (10 mg pollen grain + 1 ml 2-aminoethanol during 24h + 10 ml 0.1% $KMnO_4$ during 24h on 30 °C) resulted a peculiar stage of the biopolymer structure of the sporoderm. Namely a number of the regular pentagon units of the quasi-crystalloid skeleton were degraded.

One of them was chosen for symmetry operations by the modified Markham rotation method (cf. KEDVES, 1989a). The results are presented in this contribution.

Results

The transmission electronmicroscopical picture of the partially degraded ectexine of *Ambrosia artemisiifolia* (Plate 16.1., fig. 1) well illustrate that the biopolymer units in Angstrom dimension are not in a well preservation. On some parts in this picture molecular units sensu strictu are perceptible. A relatively very damaged regular pentagon was chosen for symmetry operations. The units of this regular pentagon are numerated, and the rotation axis PA is indicated. Picture 1a represents the result of the fivefold rotation (C.P.5.A.5.5.). The pentagonal rotation area is well shown its sides are parallel with those of the basic pentagon. But there are no characteristic positive or negative secondary points of symmetry around the rotation centrum. The result is similar at the tenfold rotation (Plate 16.1., fig. 1b). There are no characteristic points of symmetry around the rotation centrum except the first circle when there are ten dark points of symmetry. Around the rotation area there are ten clusters of cyclic molecules. One central molecule is surrounded by five other cyclic molecules, which are ressembling to another molecular Penrose unit.

In a highly magnified picture (Plate 16.1., fig. 2) all clusters of molecules are numerated altogether ten. Plate 16.2. illustrates in very highly magnified picture the results of the tenfold rotation. The biopolymer clusters 4 and 5 are well shown, and the surrounding cyclic molecules are numerated.

Discussion and Conclusions

As we have previously emphasized, the metastable quasi-crystalloid skeleton together with its stabilizing molecular systems are one component of the spore wall. These units may be building elements of the other kinds of highly organized elements such the helical structures in nanometer dimension (cf. ROWLEY et al. 1981).

In another paper we have demonstrated that the quasi-crystalloid structure may be present also on molecular level (KEDVES, TÓTH and FARKAS, 1993). But the regular pentagonal molecule was not in the rotation area of the biopolymer structure. Further molecular clusters were demonstrated from the partially degraded ectexine of *Encephalartos transvenosus* by KEDVES, PÁRDUTZ, TERBE and HORVÁTH (1999). The central cyclic molecule is surrounded by six cyclic molecules. The symmetry operation of the molecules of this cluster is in progress.

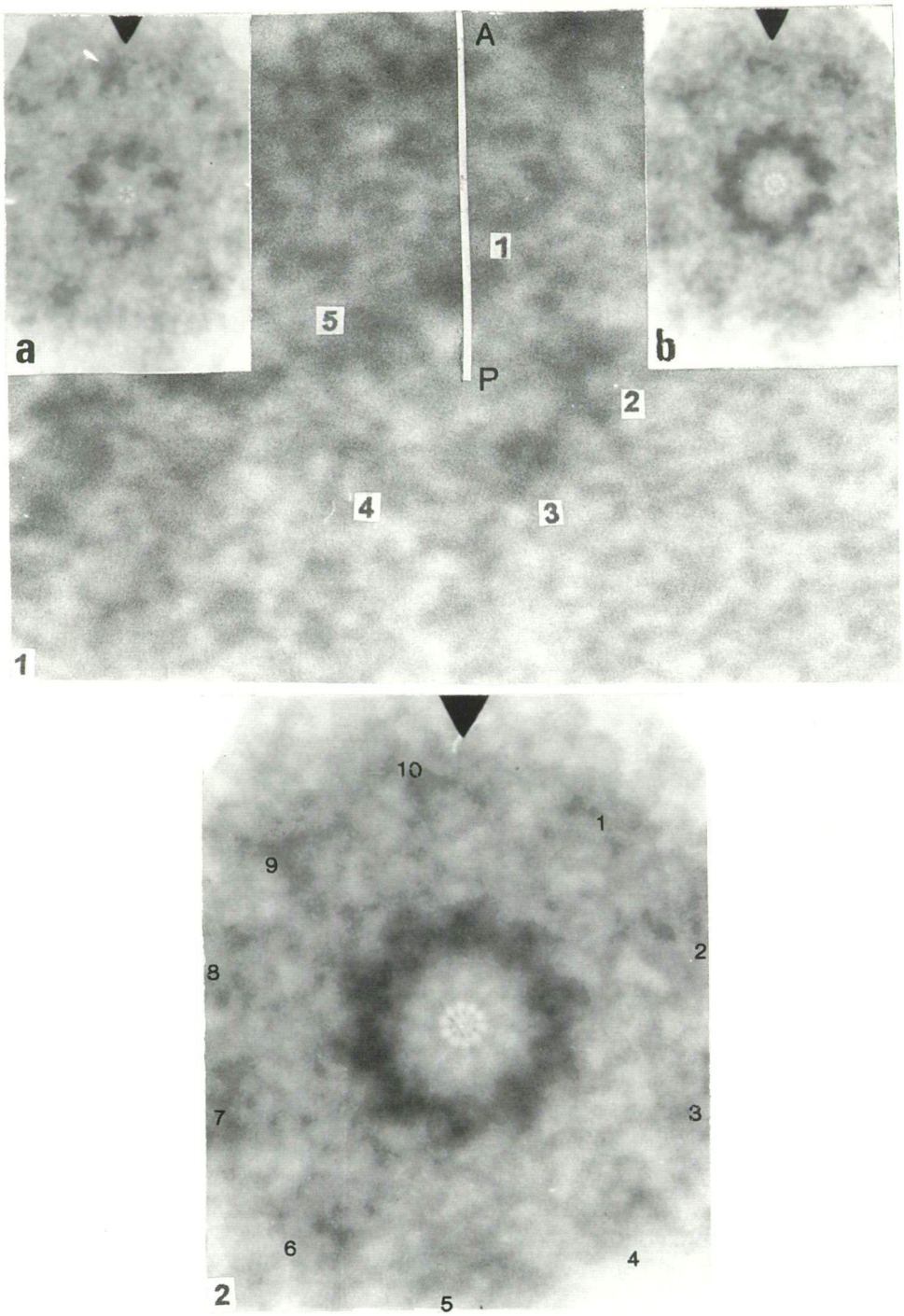


Plate 16.1.

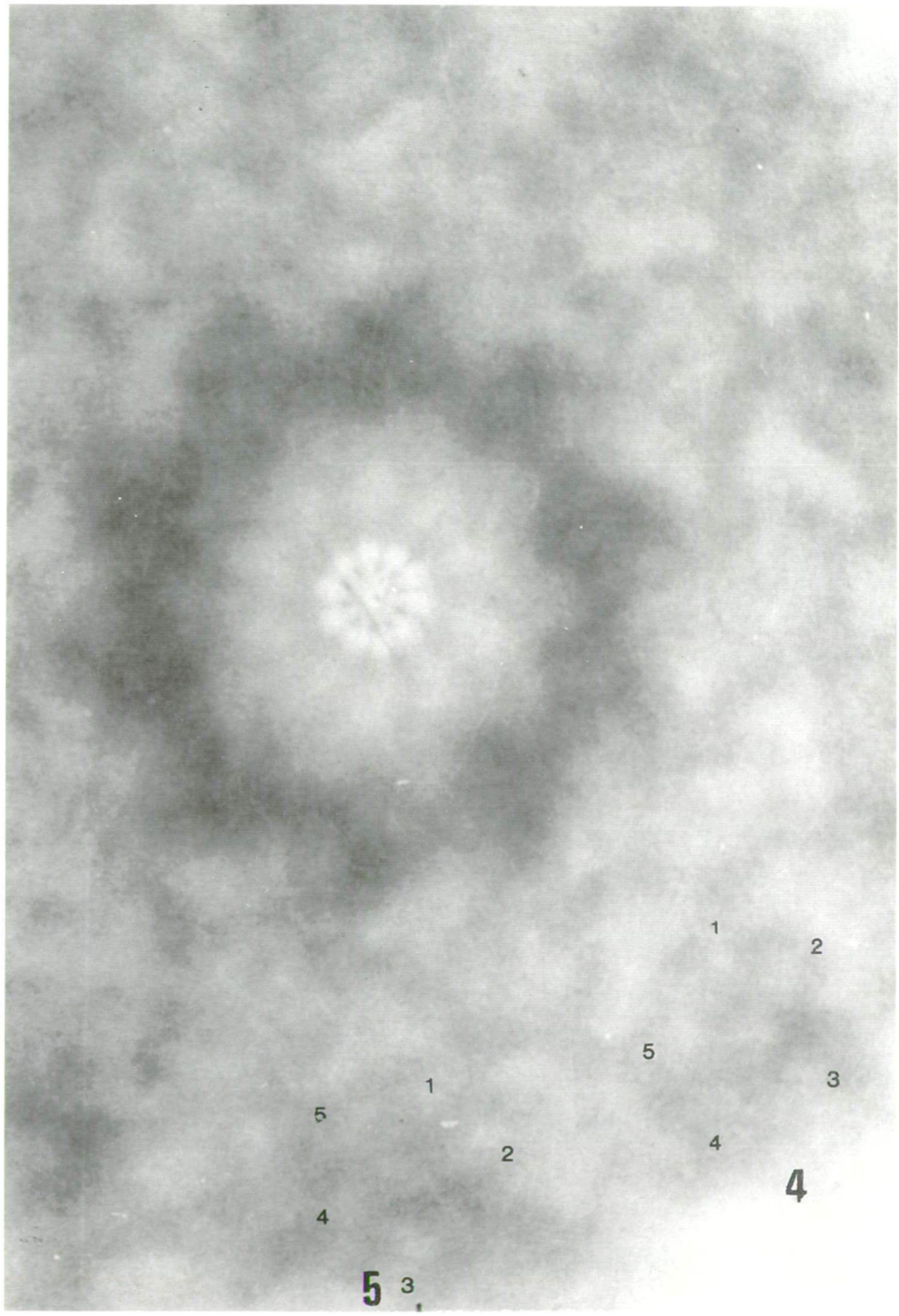


Plate 16.2.

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Plate 16.1.

1,2. *Ambrosia artemisiifolia* L., TEM picture of the partially degraded exine
1. Ultrastructure of the partially degraded ectexine. Experiment No: 1394, negative no: 7560, 2,500.000x.
1a,b. Rotation pictures 1,000.000x.
1a. C.P.5.A.5.5.
1b. C.P.5.A.5.10.
2. C.P.5.A.5.10, 2,000.000x.

Plate 16.2.

C.P.5.A.5.10 rotation picture 5,000.000x. The five surrounding units of the 4th and 5th Penrose-like molecular clusters are numerated.

17. TRANSMISSION ELECTRON MICROSCOPY OF PARTIALLY DISSOLVED EXINES OF PSEUDOTSUGA MENZIESII (MIRB.) FRANCO

M. KEDVES and A. BORBOLA

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O.Box 993, Szeged, Hungary

Abstract

Pollen grains of *Pseudotsuga menziesii* (MIRB.) FRANCO were partially dissolved with organic solvents and investigated with transmission electron microscope. In this paper the most important TEM results of the partially dissolved exines are presented. The resistance of the exine may be pointed out in particular against diethylamine. The very early exine ultrastructure of the recent *Pseudotsuga* genus was compared with the ultrastructure data of fossil pollen grains.

Key words: Palynology, recent, *Pseudotsuga menziesii*, partial dissolution, TEM.

Introduction

Pollen grains of the genus *Pseudotsuga* were first investigated with transmission electron microscope by GULLVÅG (1966). In consequence of the importance of the *Pseudotsuga-Larix* pollen types in the fossil spore-pollen assemblages isolated from sediments of different ages these pollen grains were investigated in our Laboratory by different methods. High temperature effect of *Pseudotsuga menziesii* was studied by TÓTH (1997), *Larix decidua* MILL. by BORBOLA (1997). The organic solvent effect was investigated later (KEDVES et al. 1998) and the Duhoux effect was also observed at some experiments, e.g.: diethylamine, merkaptoethanol, ethanol, i-amyl alcohol.

We carried out several dissolution experiments with different kinds of organic solvents on the pollen grains of *Larix decidua* and *Pseudotsuga menziesii*, for transmission electronmicroscopic investigations.

In this paper the most important results obtained on the pollen grains of *Pseudotsuga menziesii* (MIRB.) FRANCO are presented.

Materials and Methods

The pollen material for these investigations was collected by Miss Á. ERDŐDI in the Botanical Garden of the J.A. University, Szeged, Hungary, on 01.04.1997. 20 mg pollen material was used for each dissolution experiment, during 30 days at 30 °C.

The experiments started on 11.05.1997, and ended on 11.05.1997.

No: 1/7 - 803. - 20 mg pollen grains + 0.2 ml diethylamine + 5 ml H_2O

No: 1/7 - 804. - 20 mg pollen grains + 0.2 ml merkaptoethanol + 5 ml H_2O

No: 1/7 - 805. - 20 mg pollen grains + 5 ml methanol
No: 1/7 - 806. - 20 mg pollen grains + 5 ml ethanol
No: 1/7 - 807. - 20 mg pollen grains + 5 ml n-propanol
No: 1/7 - 808. - 20 mg pollen grains + 5 ml n-butanol
No: 1/7 - 809. - 20 mg pollen grains + 5 ml i-amyl alcohol

Partially dissolved pollen grains were postfixed with 1% OsO_4 aqueous dilution and embedded in Araldite (Durcupan, Fluka). The ultrathin sections were made on a Porter Blum ultramicrotome in the EM Laboratory of the Hungarian Academy of Sciences Biological Research Center. The TEM pictures were taken on a Tesla BS-540, resolution 6-7 Å.

General problems

GULLVÅG (1966) described the ultrastructure of the pollen grains of *Pseudotsuga taxifolia* as follows, p. 439: "The outer layer consists of a three-dimensional network of rounded bars. The inner laminated layer is 0.3-0.4 μ. In the laminated layer triplets of the 50-60 Å unit lamella are rather common, but the individual lamella has also been observed...".In the same year: 1966, PETTITT published some information of the ultrastructure of *Archaeopteris* cf. *jacksonii* (*Archaeopteridales, Progymnospermophyta*). The described structure is similar to that of recent *Pseudotsuga taxifolia* published by GULLVÅG (1966). In this way the earliest ultrastructural characteristic features of the ectexine, namely the irregular spongy network of the ectexine and the lamellated endexine which appeared in the Devonian - Carboniferous was conserved in recent taxa of the genus *Pseudotsuga*. During the exine ultrastructure investigations on Mesozoic *Gymnospermatophyta* pollen grains similar exine ultrastructure was described from *Araucariacites hungaricus* DEÁK 1964 (KEDVES, 1985, 1994), and *Balmeiopsis limbatus* (BALME 1957) ARCHANGELSKY 1977 (KEDVES and PÁRDUTZ, 1974, KEDVES 1994). Further information in this subject is in the papers of ARCHANGELSKY (1994), and BATTEN and DUTTA (1997).

Results

As general establishment we can point out, that the sporopollenin of this pollen grains is very resistant against the used organic solvents, in this way we will not describe in detail all results, because most of them are essentially identical.

Experiment No: 1/7 - 803 (Plate 17.1., plate 17.2., figs. 1-3). – The ectexine is thick, and composed of irregular, globular or elongated elements. Based on our TEM data there are some differences in the details:

Plate 17.1., the elements are more or less globular and anastomose, in this way different patterns may be observed, such as linear, spongy and/or irregular. The superficial ectexinous elements are about two times larger than the inner ones. The ectexine is not completely closed, but the outer part composed of larger units may be interpreted as a peculiar tectum. The foot layer may be established by its electron density to the other parts of the ectexine. The foot layer is connected to the outer dark lamella to the ectexine by granular or irregular units. Six dark endexine lamellae may be well seen in our TEM picture. The light lamellae of the endexine are more or less degraded; there are darker substances within the light lamellae. On the inner surface in some parts there are

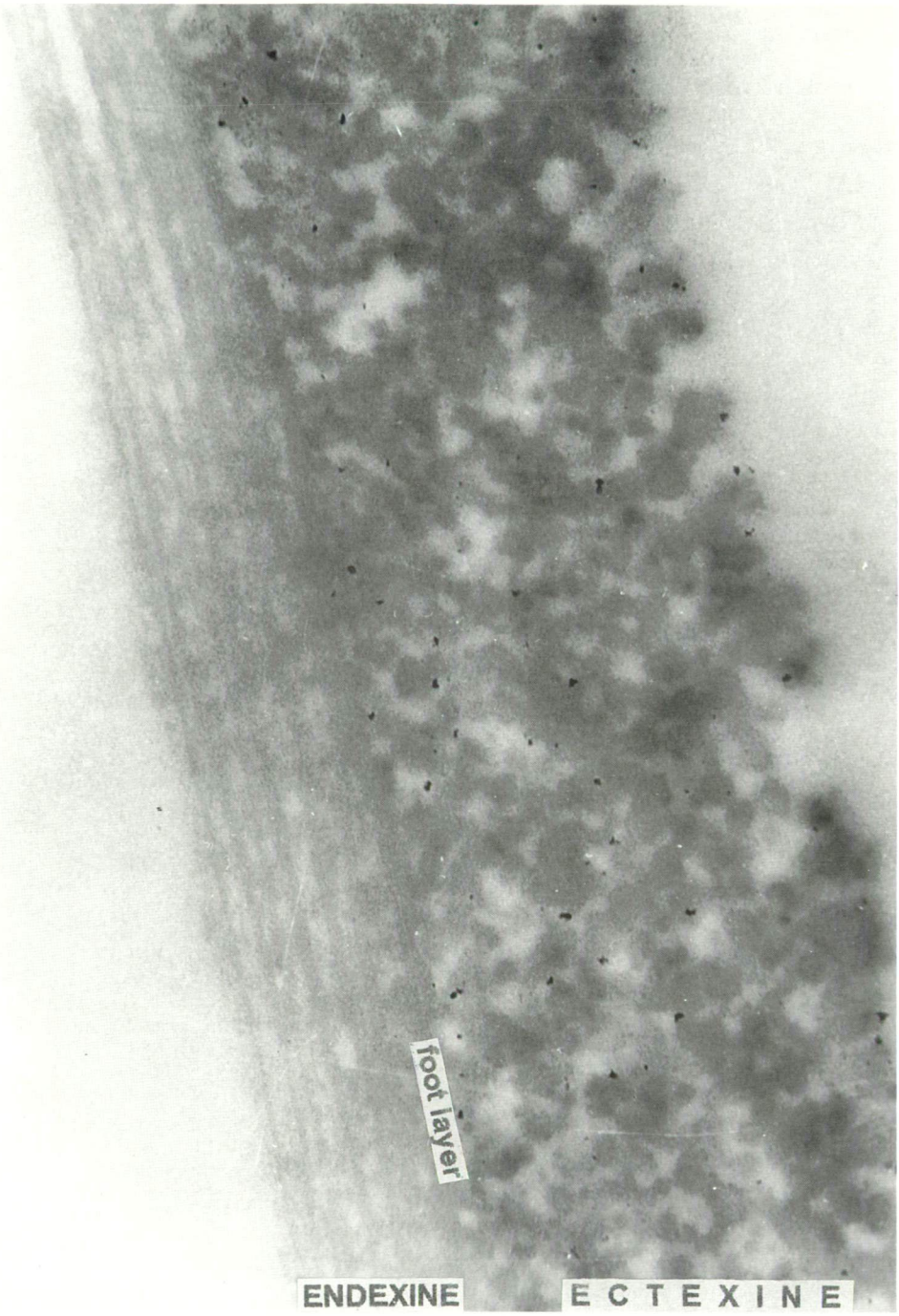

Plate 17.1.

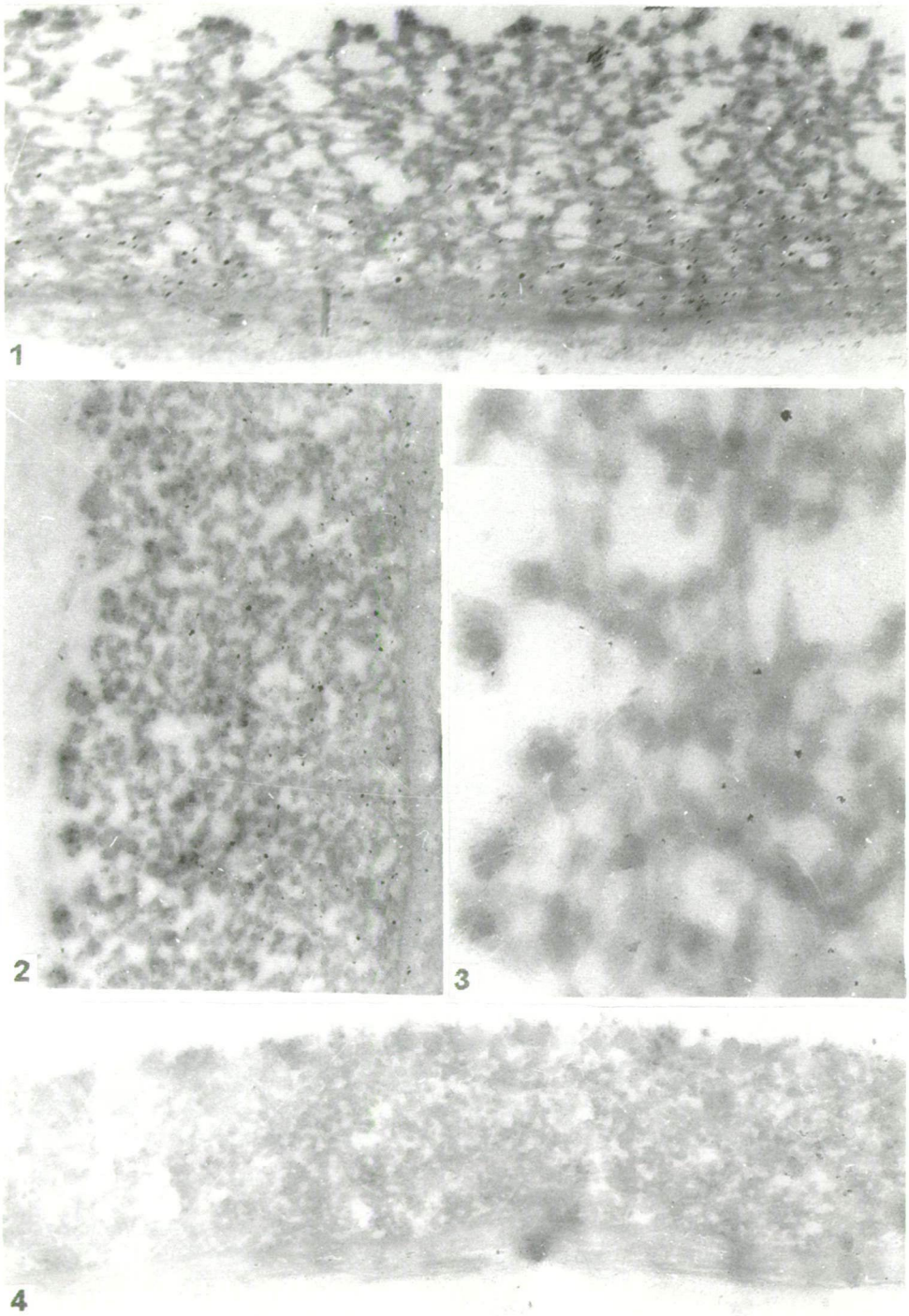

Plate 17.2.

degradations. Plate 17.2., fig. 1. - The electron density of the elements of the outer part of the ectexine is stronger than previously. Moreover, there are globular elements in the inner part of the ectexine with different electron density. The substance is rather network than spongy composed of irregular or globular elements. Degradation of the foot layer and the endexine is well shown. Plate 17.2., fig. 2. – illustrates superficial lamellae on the outer part of the ectexine. The electron density of the outer part of the ectexine - "discontinuous tectum" – is stronger that the inner part. The inner part of the ectexine is composed more or less anastomosing globular elements. The foot layer is quite perceptible, the endexine lamellae are degraded. The above mentioned ultrastructure characteristic features of the outer part of the ectexine are illustrated in a highly magnified picture in the Plate 17.2., fig. 3.

Experiment No: 1/7 - 807 (Plate 17.2., fig. 4). - In general, dissolution of the elements of the exine may be established, but the basic ultrastructural characteristic features are perceptible. So the stronger electron density of the "discontinuous tectum", and the foot layer are well shown. The lamellae of the endexine are also well seen in our TEM picture.

Discussion and Conclusions

1. The sporopollenin of the exine of *Pseudotsuga menziesii* is resistant against organic solvents in comparison to other investigated pollen grains particularly of the *angiosperms* (*Quercus*, KEDVES and GÁSPÁR, 1996, *Platanus, Tilia*, KEDVES et al., (1998), etc.).

2. The ectexine is not completely closed, probably the resistant molecular system may be explained with this characteristic feature. But on the other hand similar resistance was established at the tectate *Cycadaceae* pollen grains cf. KEDVES, PÁRDUTZ, TERBE and HORVÁTH (1999). This problem needs further investigations.

3. The basic ultrastructure characteristic features of the ectexine and the lamellar endexine is of the earliest type. To this we have several ultrastructural data from the pollen grains Paleozoic and the Mesozoic sediments. The similarity between the earliest fossil ultrastructure data to the recent species of the genus *Pseudotsuga*, may be emphasized which is an evolved *gymnosperm* pollen grain.

Plate 17.1.

Pseudotsuga menziesii (MIRB.) FRANCO, experiment No: 1/7-803. Negative no: 6980, 75.000x.

Plate 17.2.

1-4. *Pseudotsuga menziesii* (MIRB.) FRANCO, Recent.
1. Experiment No: 1/7-803. Negative no: 6983, 25.000x.
2. Experiment No: 1/7-803. Negative no: 6981, 25.000x.
3. Experiment No: 1/7-803. Negative no: 6984, 75.000x.
4. Experiment No: 1/7-807. Negative no: 6991, 25.000x.

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18. INVESTIGACIONES EXPERIMENTALES DE LOS GRANOS DE POLEN DE TECOMA STANS (L.) H.B.K.

J. A. LAGOS[1], M. KEDVES[2] y Erika HORVÁTH[2]

1. Col. Miramonte, Pje. N°10-N°3034, San Salvador, El Salvador. 2. Laboratorio de Biología celular y Micropaleontología evolutiva, Departamento de Botánica, Universidad J.A., H-6701, Apartado Postal 993, Szeged, Hungría.

Resumen

Se investigaron granos de polen de *Tecoma stans*, tanto frescos como parcialmente disueltos, de acuerdo con los métodos MO y MET. Se investigaron, estadísticamente, la protusión y el desarrollo del tubo polínico frescos y parcialmente disueltos en mercaptoetanol. Con relación a la composición de la esporopolenina de las especies investigadas, podemos enfatizar que la ectexina se disolvió con 2-aminoetanol después de 30 días, lo cual no es común en los granos de polen de las angiospermas. Una solubilidad similar fue establecida en los granos de polen de los géneros *Quercus, Platanus* y *Tilia*. El método microscópico de transmisión de electrones fue usado en granos de polen frescos y parcialmente disueltos.

Palabras claves: Palinología, reciente, experimental, *Tecoma*, MO y MET.

Introducción

Existe un buen número de publicaciones acerca de los estudios con MO de granos de polen del género *Tecoma*. Basado en los índices bibliográficos de THANIKAIMONI (1972, 1973, 1976, 1980, 1986), TISSOT (1990), TISSOT y VAN DER HAM (1994) se enumeraron 36 artículos. Los primeros datos fueron publicados por FRITZSCHE (1832) y MOHL (1835).

BUURMAN (1977) investigó, en detalle los granos de polen de las bignoniáceas con los métodos MO y MEB. Desde el punto de vista palinomorfológico de los polenes, tomando como tipos básicos del género *Arrabidea* 8 y el tipo *Tecoma*, se establecieron 12 géneros. Varios linajes fueron derivados de los tipos básicos.

Tomando en consideración las peculiaridades en la morfología de las bignoniáceas y la posición particular de los granos de polen del género *Tecoma*, llevamos a cabo investigaciones combinadas de los granos de polen de *Tecoma stans*.

El propósito de este artículo es el siguiente:

1. - Descripción de la morfología con MO y MET de los granos de polen frescos de las variedades observadas.

2. - Investigar la solubilidad de la esporopolenina de la exina, en disolución parcial, de los granos de polen con dietilamina y mercaptoetanol e investigar ambas alternaciones con MO y MET.

3. - Hacer una evaluación comparativa de nuestros datos con los resultados publicados previamente (Ej.: KEDVES y GÁSPÁR 1994, 1996, KEDVES, KÁROSSY y BORBOLA, 1997, KEDVES et al., 1998).

Materiales y Métodos

Los materiales para la investigación fueron recolectados por el primer autor el 2 de enero de 1997. Localidad: San Salvador. Los granos de polen fueron puestos en jalea de glicerina hidratada el 39.6%.

Experimento N° 1/7-1049: granos de polen de 20 piezas de estambres + 5 ml de agua destilada + 0.2 ml de dietilamina.

Experimento N° 1/7-1050: granos de polen de 20 piezas de estambres + 5 ml de agua destilada + 0.2 ml de mercaptoetanol.

Temperatura: 30 grados centígrados, período de tiempo: 30 días.

Después de la disolución parcial, el material de polen fue lavado con agua destilada y coloreado con azul de toluidina y montado en gelatina de glicerina.

Para los estudios MET los granos de polen fueron postfijados con 1% OsO_4 disolución acuosa y embebidos en araldita. Las secciones ultrafinas fueron realizadas en el laboratorio ME de la Hungarian Academy of Sciences Biological Research Center con un ultramicrótomo Porter Blum. Las fotografías MET fueron tomadas en una Tesla BS-540 (resulución 6-7 Å).

Resultados

1. - Resultados con el microscopio óptico (MO)

1.1. - Los granos de polen no experimentales (Lámina 18.1., figs. 1-6) tricolpados en vista polar ambitriangular con lados convexos. Superficie (escultura) finamente reticulada (Lámina 18.1., fig. 6). Diámetro 27.5-45.0 µm, la distribución de los percentajes son como siguen:

27.5	30.0	32.5	35.0	37.5	40.0	42.5	45.0	µm
2.5	9.0	17.0	24.5	28.5	13.0	2.5	3.0	%

Fueron observadas protusiones características (Lámina 18.1., figs. 4,5) y tubos polínicos, más o menos desarrollados (Lámina 18.1., fig. 2). Desde este punto de vista, fueron distinguidos cuatro grupos:

1. Granos de polen sin protusiones y tubos polínicos: 30.5% (Lámina 18.1., figs. 1,3).
2. Granos de polen con protusiones exclusivas: 27% (Lámina 18.1., fig. 4).
3. Granos de polen con tubos polínicos: 29.0% (Lámina 18.1., fig. 2).
4. Granos de polen con tubos polínicos y protusiones: 13.5% (Lámina 18.1., fig. 5).

1.2. - Experimento N°: 1/7-1049 (Lámina 18.1., figs. 7,8).

La dietilamina disolvió completamente las paredes del polen. Fueron observados remanentes del protoplasma con protusiones (Lámina 18.1., fig. 7).

1.3. - Experimento N°: 1/7-1050 (Lámina 18.1., figs. 9-13).

Fueron observadas alteraciones interesantes en el aspecto general de los granos de polen. Los diámetros y porcentajes de los granos de polen son como siguen:

25.0	27.5	30.0	32.5	35.0	37.0	40.0	42.5	µm
2.0	11.5	30.0	25.0	17.0	10.0	3.0	1.5	%

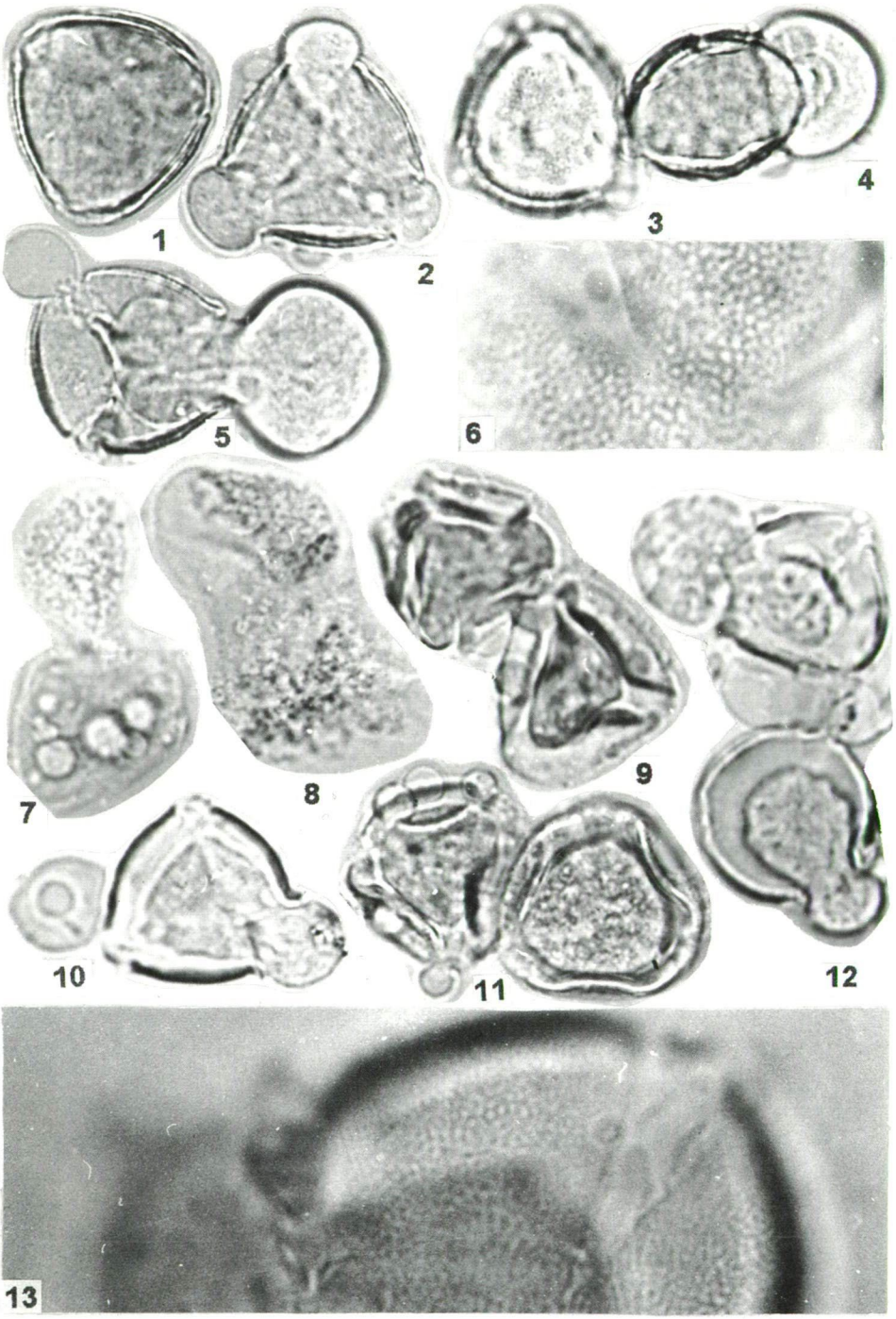

Lámina 18.1.

1. Granos de polen sin protusiones y tubos polínicos: 55.0%
2. Granos de polen con tubos polínicos: 35.0%
3. Granos de polen con protusiones: 8.0%
4. Granos de polen con tubos polínicos y protusiones: 2.0%

La fina estructura del colpo y la escultura finamente reticulada se ilustra muy bien en la foto 13, lámina 18.1.

2. - Resultados con el microscopio electrónico de transmisión (MET)

2.1. - Ultraestructura de la exina de los granos de polen no experimentales (Lámina 18.2., figs. 1-3).

En la ectexina y en el infratéctum columelar, la capa base es relativamente delgada. Bajo la capa base la intina es granular. Las secciones ultrafinas son levemente tangenciales y la escultura finamente reticulada está más o menos representadas en nuestras fotografías (Lámina 18.2., fig. 1).

2.2. - Experimento N°: 1/7-1049.

Varios bloques fueron seccionados finamente, sin resultados. Probablemente los remanentes del protoplasma fueron desintegrados duran los procesos de la imbibición.

2.3. - Experimento N°: 1/7-1050 (Lámina 18.3., figs. 1-5).

La disolución con mercaptoetanol dio por resultado alteraciones interesantes. Estas pueden resumirse como sigue:

1. Una capa de ectexina ocasionelmente peculiar fue observada (Lámina 18.3., figs. 1-3). En algunos sitios hay fragmentos ectexinos perpendicular a la capa columelar infratectal o paralela al téctum.

2. Una capa base doble apareció (Lámina 18.3., figs. 1-3). La interior pudiera ser una endexina idéntica, completamente, en su densidad de electrones y ultraestructura a la capa base en el sentido estricto. La intina, también, es levemente de doble capa (Lámina 18.3., fig. 2). La ectintina es un poco más densa en electrones que la endintina y hay numerosos gránulos pequeños. El área de aperturas está ilustrada, también, en nuestras fotográfías MET (Lámina 18.3., figs. 4,5). El téctum, la capa infratectal y la parte exterior de la capa base falta en el área del colpo. Bajo el colpo se encuentran importantes espesamientos centrípetos más o menos granulares.

Discusión y Conclusiones

1.- La composición de la esporopolenina de *Tecoma stans* basada en su solubilidad en dietilamina es particular. Un fenómeno similar fue descrito por KEDVES y GÁSPÁR (1994, 1996) en los granos de polen del género *Quercus*, pero la ectexina de *Tecoma stans* es menos resistente que la ectexina del género *Quercus*. En comparación de los experimentos de disolución adicionales (KEDVES et al. 1998) hasta la fecha, los granos

Lámina 18.1.

1-13. *Tecoma stans* (L.) H.B.K.
1-6. Microfotografías con MO de granos de polen frescos.
7,8. Experimento N°: 1/7-1049.
9-13. Experimento N°: 1/7-1050.
Figs. 6,13 x 3000; las otras x 1000.

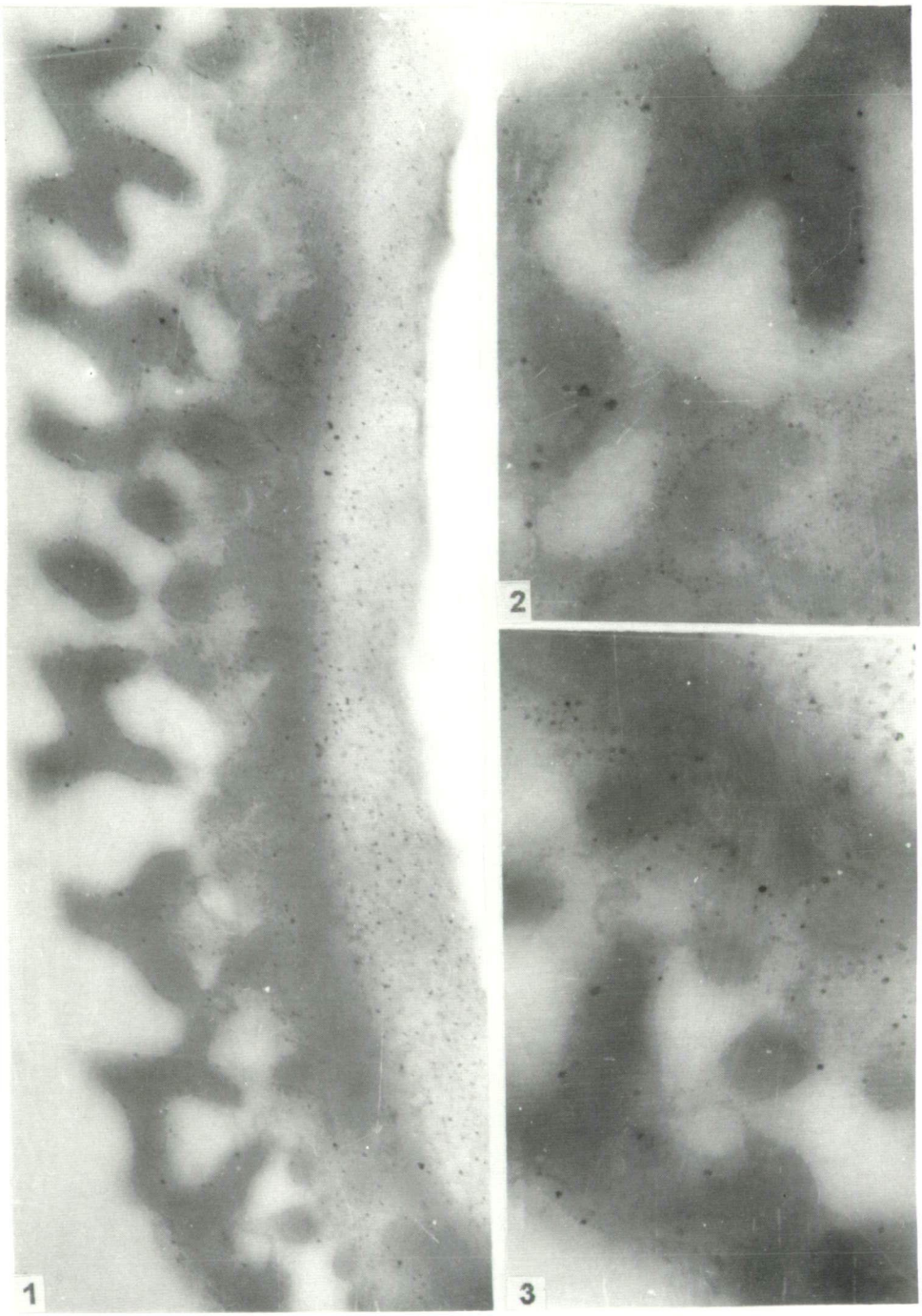

Lámina 18.2.

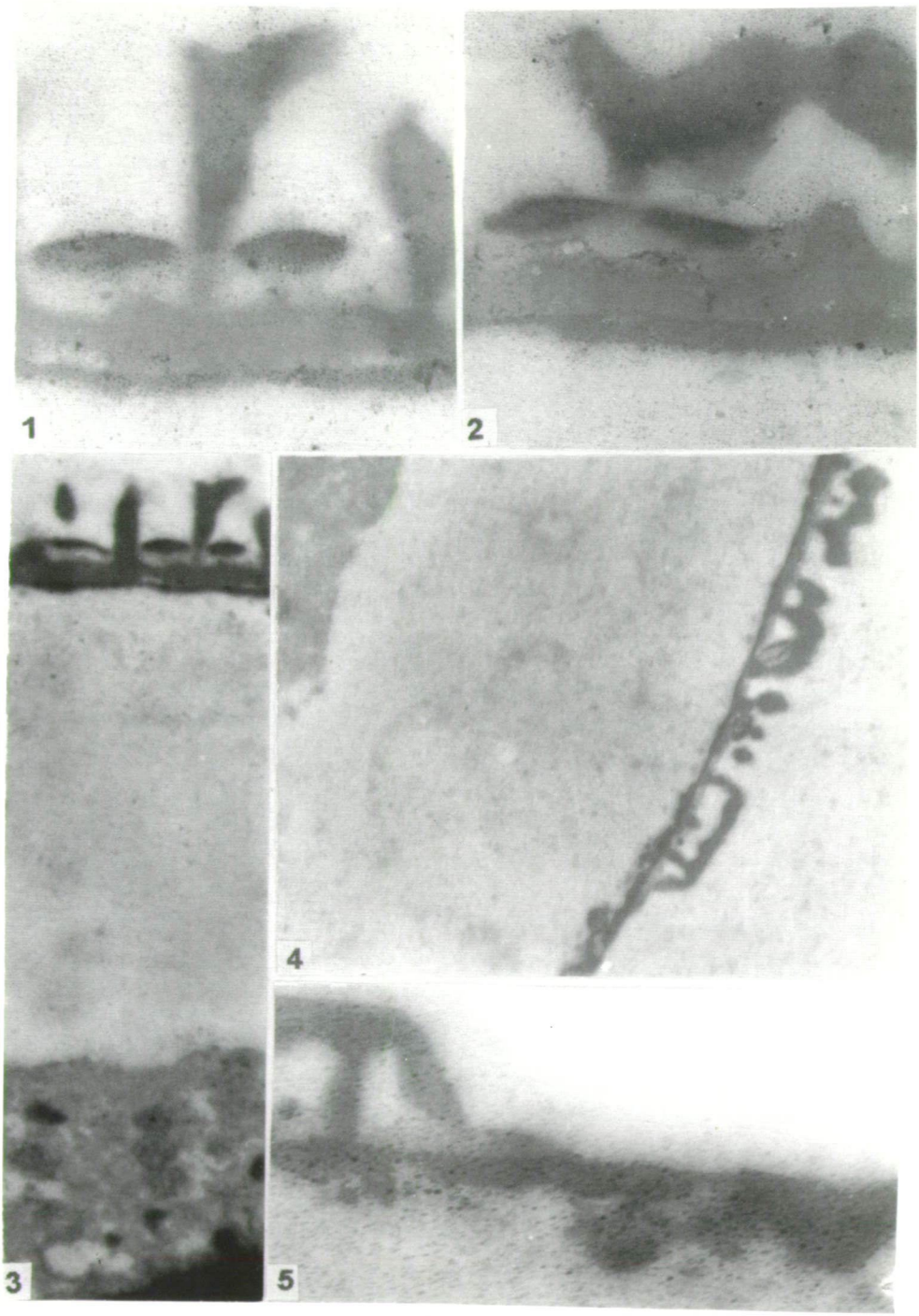

Lámina 18.3.

de polen de *Platanus hybrida* BROT. y *Tilia platyphyllos* SCOP. se disolvieron similarmente a la ectexina de *Tecoma stans*. Un sistema molecular resistente a la dietilamina fue observado en los granos de polen de las angiospermas en las especies siguientes: *Betula verrucosa* EHR., *Carya illinoensis* (WANG) KOCH, *Juglans nigra* L., *Platycarya strobilacea* SIEB. y ZUCC. (KEDVES, KÁROSSY, y BORBOLA, 1997).

2.- La ultraestructura de los granos de polen, particularmente disueltos en mercaptoetanol, es extremadamente importante. Fueron descubiertos varios rasgos característicos ultraestructurales, los cuales no eran perceptibles en el material de polen no experimental. Desde este punto de vista las capas ectexinuas y la ultraestructura del área del colpo pudieran ser enfantizadas.

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TISSOT, C. et VAN DER HAM, R.W.J.M. (1994): Septième index bibliographique sur la morphologie des pollens *d'Angiospermes*. - Trav. sect. sci. tech. Inst. Fr. Pondichéry *36*, 1-345.

Lámina 18.2.

1-3. *Tecoma stans* (L.) H.B.K. Microfotografías con MET de granos de polen frescos.
1. 25.000x.
2,3. 50.000x.

Lámina 18.3.

1-5. *Tecoma stans* (L.) H.B.K. Microfotografías con MET. Experimento N°: 1/7-1050.
1,2,5. 50.000x.
3,4. 15.000x.

19. LIST OF PUBLICATIONS OF THE LABORATORY UNTIL DECEMBER 1999

Compiled by

MADARÁSZ, M. and Andrea HORVÁTH

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

BORBOLA, A. and PAPP-NAGY, É. (1999): List of publications of the Laboratory until December 1998. - Plant Cell Biology and Development (Szeged) *10*, 98.

HERNGREEN, G.F.W., SCHUURMAN, H.A.H.M., VERBEEK, J.W., BRINKHUIS, H., BURNETT, J.A., FELDER, W.M. and KEDVES, M. (1998): Biostratigraphy of Cretaceous/Tertiary boundary strata in the Curfs quarry, the Netherlands. - Meded. Nederlands Inst. voor Toegepaste Geowetenschappen TNO *61*, 1-58.

HORVÁTH, Erika (1999): Chronicle. - Plant Cell Biology and Development (Szeged) *10*, 99-104.

KEDVES, M. (1999a): Upper Cretaceous pollen grains from Egypt III. - Plant Cell Biology and Development (Szeged) *10*, 14-29.

KEDVES, M. (1999b): Études palynologiques des couches du Tertiaire inférieur de la Région Parisienne. X. - Plant Cell Biology and Development (Szeged) *10*, 30-38.

KEDVES, M. (1999c): Wood anatomy of Hungarian Tertiary lignites. - Plant Cell Biology and Development (Szeged) *10*, 39-50.

KEDVES, M. (1999d): A kísérletes palinológia újabb eredményei. – Bot. Közlem. 84, 160-161.

KEDVES, M. (1999e): Transmission electron microscopy of Mesozoic terrestrial microfossils. – VII International Sympsium on Mesozoic Terrestrial Ecosystems, Sept. 26–Oct. 1, Buenos Aires/Argentina, Abstracts, 31-32.

KEDVES, M. (1999f): A zárvatermő pollen evolúció és a paleofitogeográfia szimmetria kérdései. – MTA SZ.T.B., Szimmetria, , Aszimmetria II, 37-42.

KEDVES, M., ALVAREZ RAMIS, C., FERNÁNDEZ MARRÓN, M.-T., CLEMENTE BELMONTE, P. & GOMEZ PORTER, P. (1999): Sporomorphs isolated from pre-Quaternary sediments of „Barranco de Patones" (Spain). – Ann. Univ. Sci. Budapestinensis, Sect. Geol. *32*, 57-71.

KEDVES, M., BORSODI, A., DOBÓ, K., KOVÁCS, E. et SZÉCSÉNYI, A. (1999): L'effet de l'hydratation sur les grains de pollen des *Cycadales*. - Actes du IV^{ème} Symposium Internationale de Palynologie Africaine - 15-30 Avril 1999 Sousse/Tunisie, 41.

KEDVES, M., HORVÁTH, E., BORBOLA, A. and TÓTH, A. (1999): LM investigations of partially dissolved sporomorphs III. - Plant Cell Biology and Development (Szeged) *10*, 75-82.

KEDVES, M. and KEDVES, L. (1999): Computer modelling of the quasi-crystalloid biopolymer structure IV. - Plant Cell Biology and Development (Szeged) *10*, 91-97.

KEDVES, M. and PÁRDUTZ, Á. (1999a): Transmission electron microscopy of Hungarian Tertiary lignites I. - Plant Cell Biology and Development (Szeged) *10*, 51-61.

KEDVES, M., PÁRDUTZ, Á., MADARÁSZ, M. et HORVÁTH, A. (1999): Microscopie électronique à transmission de l'exine partiellement dégradée de grains de pollen *d'Ambrosia artemisiifolia*. - XVIème Symposium de l'A.P.L.F., Liège, Résumés,

KEDVES, M., PÁRDUTZ, Á., TERBE, Zs. et HORVÁTH, Eszter (1999): Microscopie électronique à transmission de l'exine partiellement dégradée de grains de pollen de quelques *Cycadales*. - Actes du IV^{ème} Symposium Internationale Palynologie Africaine - 15-30 Avril, 1999 Sousse/Tunisie, 35.

KEDVES, M., PÁRDUTZ, Á. and TÓTH, A. (1999a): X-ray effect on the ultrastructure of the pollen grains of *Salix alba* L. - Plant Cell Biology and Development (Szeged) *10*, 66-74.

KEDVES, M., PÁRDUTZ, Á. and TÓTH, A. (1999): Ultrastructure of partially dissolved pollen grains of *Platanus hybrida* BROT. - Plant Cell Biology and Development (Szeged) *10*, 83-90.

SRIVASTAVA, SHYAM, C. (1999): Reconstruction and affiliation of Middle Triassic seeds from India. - Plant Cell Biology and Development (Szeged) *10*, 8-13.

In memoriam

Eugène Boltenhagen (1906 - 1999)

J. DEJAX et M. SALARD-CHEBOLDAEFF

Muséum National d'Histoire Naturelle, Laboratoire de Paléontologie URA 12 CNRS, F-75005 Paris, France

Né le 1er Novembre 1906 à Saint-Petersbourg (Russie), Monsieur Eugène BOLTENHAGEN s'éteignit le 10 Février 1999 à Paris.

Après ses études secondaires suivies dans sa ville natale, il émigra avec sa famille d'abord en Finlande où il vécut jusqu'en 1924 à Helsinki, puis en Belgique où il obtint en 1928 le diplôme d'ingénieur agronome de l'Université Catholique de Louvain. C'est la France qu'il choisit comme terre d'adoption: il fut naturalisé français en 1933. Ses études s'achevèrent à Nancy, où le titre d'ingénieur civil des Eaux et Forêts lui fut décerné.

Monsieur BOLTENHAGEN s'éloigna peu après de la métropole en se dirigeant vers l'Afrique... Ce continent, alors bien méconnu sur le plan géologique, allait devenir le creuset de ses recherches et le terrain d'explorations difficiles dont il fut l'un des pionniers... Ainsi, il partit en 1934 prospecter au Gabon pour la "Société du Haut-Oogoué". De 1937 à 1939 un contrat le lia à la Compagnie Française des Pétroles et il obtint parallèllement le Certificat d'Études Supérieures de Minéralogie à la Faculté des Sciences de Nancy. Mobilisé en 1939, il fut affecté au "Syndicat d'Études et de Recherches Pétrolières" jusqu'en 1946, puis muté au "Centre de l'Energie atomique", devint chef-prospecteur à Madagascar. En 1950, le diplome d'ingénieur-géologue lui fut décerné.

L'Afrique était devenue la deuxième patrie de notre collègue récemment disparu : il y repartit pour servir à nouveau l'industrie pétrolière, travaillant au Cameroun, au Gabon mais aussi à Madagascar comme opiniâtre cartographe, puis géologue des sondages et chef de laboratoire à la "Société des Pétroles d'Afrique Equatoriale" (S.P.AF.E.) ; il dressa notamment la carte topographique et géologique du bassin littoral du Gabon.

En ce vaste continent, dans les années cinquante, le trépan s'aventurait en *terra incognita*... En l'absence de tout repère, un nouvel outil dut être forgé : la paléo-palynologie ouest-africaine s'ébaucha sous l'impulsion de Monsieur Boltenhagen, qui devint palynologue pour les besoins de la cause : avec quelques collaborateurs, penché sur le microscope, il se livra aux premières observations des palynomorphes extraits des sédiments livrés par les premiers forages, à l'aube de cette épopée industrielle... Ainsi, l'équipe qu'il dirigeait esquissa le canevas de l'échelle biostratigraphique ouest-africaine du Crétacé, traça des corrélations entre les divers puits, tout en s'interrogeant sur la tectonique à l'aide de données fournies par d'autres méthodes telle la "sismique réflexion", outil encore nouveau lui aussi...

De retour en France métropolitaine en 1956, Monsieur BOLTENHAGEN poursuivit ce travail, organisant le laboratoire de palynologie de la "S.P.AF.E." qu'il dirigea jusqu'en Mars 1965 ; cette société fut ensuite incorporée au sein du groupe ELF.

En 1971, E. BOLTENHAGEN prit sa retraite... Mais ce fut pour s'adonner encore à ce qui était devenu une vraie passion, la paléo-palynologie appliquée à l'Afrique de l'Ouest: il devint chercheur-libre au Laboratoire de Paléontologie (Paléobotanique) du Muséum national d'Histoire naturelle. Très assidu au microscope, il y prépara une thèse de Docteur-Ingénieur de l'Université Pierre et Marie Curie (Paris VI) intitulée "Palynologie du Crétacé supérieur du Gabon" qu'il soutint en 1979, à 73 ans : vaste synthèse de toute son expérience de terrain et de ses minutieuses et innombrables observations. Durant cette dernière période d'activité, Monsieur BOLTENHAGEN publia de nombreux articles concernant ces grains de pollen, spores et autres kystes de dinoflagellés auxquels il consacra l'essentiel de son activité de chercheur, les décrivant en respectant méticuleusement la terminologie et les classant toujours avec rigueur selon la classification morphographique (dont il était l'ardent partisan) tout en s'attachant à en définir les affinités botaniques, les rapprochant le plus possible des taxons actuels. Il légua une partie de cette immense expérience aux deux signataires de cet affectueux hommage, avec la patience et la bienveillance parfois bourrue de celui qui -avant de devenir un universitaire- sut ce qu'est le travail de terrain dans cette brousse africaine dont il apprit à percer le secret.

Chronicle

compiled by

ZS. TERBE

International Laboratory activities

23 February - 08 March, 1999, Lucknow, Uttar Pradesh, India.

Under the Indian National Science Academy - Hungarian Academy of Sciences, Exchange of Scientists Programme, Prof. Dr. M. KEDVES worked in the Birbal Sahni Institute of Palaeobotany. Within the joint research program of the BSIP and the Laboratory, the following manuscript was completed:

KEDVES, M., BORBOLA, A., TRIPATHI, S.K.M. - MADHAV KUMAR: Transmission electron microscopic studies on partially degraded pollen grains of *Phoenix sylvestris* LINN.

Bibliographical data were disposable in the great library of the BSIP for the elaboration of further research programs of the Laboratory:

1. Variation-statistical investigations on the spores of the genus *Ceratopteris*.
2. Transmission electron microscopic investigations of partially degraded pollen grains of *Ambrosia artemisiifolia* L.

As regards the further scientific collaboration fruitful discussions were continued with the Heads and staff of the Birbal Sahni Institute of Palaeobotany.

Indian - Hungarian scientific relations

On the 16th June 1999 at 16:00 o'clock the Office of the International Collaboration of the Hungarian Academy of Sciences and the Hungarian-Indian Friendship Society organized an exclusive reception in the House of Nations in Budapest. At this occasion Her Excellency Mrs. LAKSHMI M. PURI the new Ambassador of the Indian Republic delivered a lecture on the subject of the international scientific relations of India. At this reception she met Hungarian scientists who worked within the scientifical programs of the two countries.

Mrs. LAKSHMI M. PURI Ambassador of India invited Dr. M. KEDVES to a lecture by the Ministry for Science and Technology of the Republic of India Mr. H.E. Dr. MURLI MANOHAR JOSHI, on Science and Technology in India: Past Acheivments and Plans for the 21st Century. The lecture was presented in the India House on the 29th June at 17:30 o'clock in Budapest. The lecture was followed by a Buffet Dinner. The excellent lecture and the tasty indian foods made this occasion unforgettable.

24 April - 2 May, 1999, Sousse, Tunis.

At the 4th Symposium of African Palynology the following oral communications were presented by Prof. Dr. M. KEDVES:

28 April, KEDVES, M., PÁRDUTZ, Á., TERBE, ZS. et HORVÁTH, E.: Microscopie électronique à transmission de l'exine partiellement dégradé de grains de pollen de quelques *Cycadales*.

KEDVES, M., BORSODI, A., DOBÓ, K., KOVÁCS, E. et SZÉCSÉNYI, A.: L'effet de l'hydratation sur les grains de pollen des *Cycadales*.

13-19 September, 1999, Liège, Belgium.

The following lecture was delivered by Prof. Dr. M. KEDVES at the XVIth Symposium of A.P.L.F.:

16 September, KEDVES, M., PÁRDUTZ, Á., MADARÁSZ, M. et HORVÁTH, A.: Microscopie électronique à transmission de l'exine partiellement dégradée de grains de pollen d'*Ambrosia artemisiifolia* L.

26 September - 1 October, 1999, Buenos Aires, Argentina.

At the VII International Symposium on Mesozoic Terrestrial Ecosystems, the following contribution was presented on the 1st October:

KEDVES, M.: Transmission electron microscopy of Mesozoic terrestrial microfossils.

Hungarian Scientific Activities

On the 14th January, 1999, appeared the 10th appeared of Plant Cell Biology and Development.

At the 1347th meeting of the Botanical Section of the Hungarian Biological Society on the 19th April, the following lecture was delivered by M. Kedves:

"Kísérletes vizsgálatok *Cycadaceae* pollenszemeken" (Experimental investigation on *Cycadaceae* pollen grains).

On the 29th November at the 1353th one, the following paper was delivered by Prof. Dr. M. KEDVES:

KEDVES, M., PÁRDUTZ, Á. és MADARÁSZ, M.: A parlagfű virágporszemein elért eddigi kísérletes ultrastruktúra vizsgálatok eredményei (The present day experimental ultrastructural results on the ragweed pollen grains).

Laboratory meetings

06.02.1999.

The present state of the volume 11. of Plant Cell Biology and Development.

The contribution of the Laboratory at the international scientific meetings held in Sousse, Tunis, and Liège, Belgium.

Preparations of the new experimental studies. Speaker: M. KEDVES.

13.02.1999.

Spore and pollen morphology, diapositive projections by M. KEDVES, and actual businesses of the Laboratory.

13.03.1999.

Report on the scientific study-tour in India (Lucknow, Birbal Sahni Institute of Paleobotany), and diapositive projections from Lucknow, and from spores and pollen grains (M. KEDVES).

27.03.1999.

Discussion of the papers of the jubilee volume of Plant Cell Biology and Development.

Diapositve projections (Tenerife, Canary islands) and pollen grains, by M. KEDVES.

15.05.1999.

Report on the 4th Symposium of African Palynology, and actual businesses of the Laboratory. Speaker: M. KEDVES.

Plate 1.

21.08.1999.

On the occasion of the 9th Anniversary of the Laboratory an exclusive reception was held for the members of the Laboratory. Prof. Dr. M. KEDVES introduced the awarded persons and their work.

04.09.1999.

The final editing of the volume 11. of Plant Cell Biology and Development. Preparation of volume 12. and the contract with the Juhász Printers Office. The contribution of the Laboratory at the scientific meetings of next year. Preparation of the up-to-date scientific programs of the Laboratory. Speaker: M. KEDVES.

09.10.1999.

Report on the participation of the Symposia held in Liège and in Buenos Aires, and actual businesses of the Laboratory, by M. KEDVES.

20.11.1999.

Preparation of papers for the volume 12. of Plant Cell Biology and Development. The contribution of the students in editing the next volume. Actual businesses (M. KEDVES).

18.12.1999.

Review of the achievements of the Laboratory at the end of the Millennium, and further scientific and educational programs of the Laboratory. Speaker: M. KEDVES.

Teaching program of the Laboratory

During 1999 the following lectures were delivered:

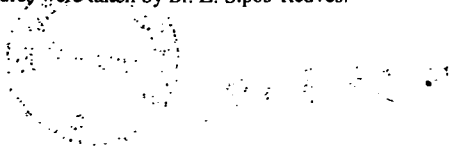
1. Introduction to the Palynology of pre-Quaternary deposits, PhD course, 1 + 2 hours weekly.
2. Applied Palynology, 1 + 2 hours weekly.
3. Biopolymer organization and Symmetry, 1 + 2 hours weekly.
4. Theory of the Evolution and Natural Philosophy, 1 hour weekly.
5. Basic palynology, 1 + 2 hours weekly.
6. Quasi-crystalloid biopolymer structure, 1 + 2 weekly.
7. Basic Supernova Theory, 1 + 0.

The following diploma work themes were delivered for students by the Laboratory:

1. Organization and symmetry of the plant biopolymers.
2. LM and TEM investigations of the experimental secondary alterations of spores and pollen grains.
3. Transmission electron microscopy of the partially degraded plant tissues.

Plate 1

Staff of the Laboratory. 1. - From left to right: M. Madarász, A. Szécsényi, Prof. Dr. M. Kedves, A. Borsodi, J. Sashalmi, Zs. Terbe. 2. - J. Sashalmi. 3. - M. Madarász and E. Horváth. 4. - D. Tombácz and A. Horváth. 5. - A. Borbola. The pictures were taken by Dr. É. Sípos-Kedves.



Award

During this year Prof. Dr. M. KEDVES was awarded with the gold medal of the "American Biographical Institute 2000 Millennium Medal of Honor" (Fig. 1.).

Fig. 1.

Front side of the gold medal of the "American Biographical Institute 2000 Millennium Medal of Honor". The picture was taken by Dr. I. Bagi.

Responsible for publication: M. KEDVES
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